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POSSIBLE MARKETS FOR DIRIGIBLES

Transconsult, Paris, France

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Secrétariat d'Etat auprès du Ministre de l'Equipement (Transports)
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Direction Générale de l'Aviation Civile
Direction des Programmes Aéronautiques Civils

0. INTRODUCTION

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The implementation of dirigibles into a transport system requires a preliminary background study to be carried out on several series of problems, the main ones of which are :

a) The technical feasibility of dirigibles : The basic studies are conducted in France by the ONERA. The applied studies are executed by possible manufacturers from the traditional aeronautics sector (motors, airframes, propellers, landing gear ...), as well as by unrelated sectors (industrial gas, envelopes, metal frames, handling processes) = some ship-building yards or certain metal frame experts, for example, have been interested by the prospect of manufacturing dirigibles.

b) Studies relating to the technical operation of dirigibles, their integration into airway systems, their ground organization requirements, the conditions for procuring certificates of airworthiness, etc ... must be conducted or strictly controlled by the administration. It appears that such studies have been only very superficial until the present time.

c) The present document is an integral part of an in-depth research program on the requirements, market evaluation and determination of characteristics and operational efficiency of one or several dirigibles to be manufactured.

d) The financing for the construction of dirigibles may be provided by the government or by private capital, or more probably by a combination of both with respect to commercial and civilian aircraft. An international financing may be considered. The government should finance the military aircraft(s).

e) The study of commercial and technical operating conditions of dirigibles for transportation and aerial work and the integration of this new technique into the general transport system.

Studies of series a) and b) have been undertaken or conducted by government services and by manufacturers.

Studies of series c) have been undertaken in connection with (GIE Dirigible for heavy transport) or by manufacturers, and, in particular, by Aérospatiale in France.

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TRANSCONSULT has been called on to undertake such studies : lumber transport market in tropical Africa - transport of "light" and bulky loads. These studies must be more thoroughly researched and the present document attempts to undertake this task. /2

It appears that studies of series d) have not been undertaken.

Studies of series e) are still premature. They shall nevertheless be quickly undertaken should it be decided to manufacture the dirigible. In fact, the operating conditions of this equipment are likely to be uncharacteristic of usual operating conditions of aeronautic equipment and may be more similar, in some cases, to the operating conditions of naval equipment.

The study of the demand for an extremely wide range of uses should be undertaken, and the possible applications are, in fact, quite numerous, and, as in the case of the helicopter, they will be brought to light during the adjustment and operation of this type of equipment.

The very large inventory which we have initiated is naturally likely to result in an undetermined number of variants. A synthesis shall therefore be necessary to define a "family" of dirigibles, which have variable characteristics with respect to :

.radius of action : we may, for example, consider the dirigible as handling equipment over short or very long distances, or as a means of transportation over long distances.

.transport capacities : the tonnages may vary from a few tons to several hundreds of tons.

.the types of products transported : they may be indivisible or bulk masses of containers of various goods, vehicles, or passengers.

.guidance techniques and to the accuracy of loading and unloading : this accuracy may be in centimeters or millimeters for large tonnage parts (tank components of nuclear plants) or with even greater precision. Moreover, dirigibles may be conceived of as being completely autonomous or guided by cable along a predetermined course and over short distances.

.weather resistance

.loading and unloading processes and procedures

.the presence or absence of personnel on board

.etc ...

Much consideration has already been given to the possibilities /3
of dirigibles, particularly in countries where preliminary plans have already been drafted : this consideration permits an inventory of possible applications to be outlined, but this inventory can be neither complete, nor final (analogy with helicopter or air cushion techniques, for example).

Four main sectors may nevertheless be defined and they will constitute the framework of the present study.

The Transport of Goods

This transport may be independent or combined with the handling itself of goods, since the dirigible is likely to be free of ground equipment and may provide, where necessary, door-to-door deliveries.

The types of conveyances under consideration are very diversified with respect to distances to be covered, tonnages to be transported, loading and unloading techniques to be provided. Even though this is a matter of aerial work, the handling combined with transport has been grouped, per commodity, under the present title.

Aerial Work

The aerial work missions which dirigibles are likely to provide are multiple, diversified and sometimes difficult to classify. They may or may not imply the conveyance of specialized materials, which are more or less heavy and bulky, or of crew members in various numbers.

The Transport of Passengers

The transport of passengers appeared to be essential at the beginning (Zeppelin), then seemed less important, but a new interest has arisen for this sector, particularly due to the prospects for cruises.

Military Applications

Besides military missions for the conveyance of goods, the transportation of passengers and for aerial work, dirigibles may be used for a few purely military missions. The latter shall be only roughly outlined, as it does not belong to the objective of the present study.

THE STUDY FRAMEWORK SHALL BE PRESENTED IN ACCORDANCE WITH THE OUTLINE /4
BELOW :

1. GENERAL PRESENTATION OF MISSIONS TO WHICH THE DIRIGIBLE IS LIKELY TO BE ASSIGNED

The conveyance of goods and passengers, aerial work, military missions.

This general presentation shall follow a preliminary chapter reviewing information pointing to a new use for the dirigible balloon.

2. IN-DEPTH STUDY OF CHARACTERISTIC MISSIONS

These missions shall form an integral part of the general outline presented in the preceding chapter.

The following points shall, in particular, be presented :

- .Description of the missions
- .Presentation and study of competing means
- .Advantages of using the dirigible
- .Description of the type(s) of dirigibles under consideration to meet the requirements of the mission
- .Market evaluation

3. COMPREHENSIVE MARKET EVALUATION OF A FEW REPRESENTATIVE COUNTRIES WHERE CONSIDERATION MAY BE GIVEN TO THE OPERATION OF SEVERAL TYPES OF DIRIGIBLES

The conclusion shall present a summary table of possible missions for the dirigible. The table includes an outline of desirable characteristic for the equipment proposed.

I. GENERAL PRESENTATION OF THE MISSIONS TO WHICH THE DIRIGIBLE IS LIKELY TO BE ASSIGNED /5

1.1. THE CONTEXT

For a long period of time, conveyance by the dirigible seemed to belong to history. The renewed interest in this type of transport is explained by a few developments, which it appeared interesting to review and make comments on.

These developments relate to the possible techniques of constructing the dirigible, to the types of missions it may be used for, to the environment, and to the current economic outlook.

Even though certain favorable conditions have been combined, there are nevertheless several problems to be solved, which have also been outlined.

1.1.1. The Development of Techniques for the Manufacture of Dirigibles

The dirigible, such as it was designed and constructed prior to the conflict of 1939 - 1945, can no longer be used in the current system of transportation. This is mainly for safety reasons, due to the use of hydrogen, which is particularly inflammable. The obligatory use of helium, which is now available in large quantities and at an acceptable price, opens up new prospects.

Furthermore, the development of the power and of the feasibility of all aeronautical equipment opens up numerous possibilities both in terms of propulsion and in terms of navigation, positioning and design of structures and airframes ... /5

New products (light composite materials, progress made in envelopes, etc ...) or new technologies (welding or gluing of this metals, etc ...) results in new prospects for the industrial production of dirigibles to be used for transportation and aerial missions.

Certainly, the safety requirements are without comparison with what they were 40 years ago, but technological progress has grown at a much faster rate.

1.1.2. The Development of Missions to which the Dirigible is likely to be Assigned /6

The techniques of transport which serve the economy have developed at an extremely fast rate, especially since the War of 39-45 when the concern for operational efficiency surpasses, in many cases, the concern for economics.

Requirements have developed even faster. In many cases, there is a gap between the needs which cannot be satisfied, or in all cases which cannot be satisfied within desired time limits, and the means which are technically and financially possible to employ.

The gap between requirements and means in the transport field exists on three levels, namely :

.The physical characteristics of objects to be transported become such that the available means of transport and handling are inadequate, in spite of the considerable progress made in most means of transportation.

Currently, the increase in loads per unit of area which are likely to be produced by industry is slowed down by the inadaptability of transport vehicles (and equipment), with respect to tons per unit of area and desired clearances : the investment in surface necessary to meet the requirements is expected to be substantial and sometimes difficult to consider, for physical reasons. Furthermore, the depreciation of this investment should be made on a limited number of transport operations.

.Even when there is no special problem regarding the characteristics of the objects to be conveyed, the volume of traffic streams reaches a level where the ground equipment appears to be inadequate.

We have come to a point in developed countries where there is a saturation of the transport system, which corresponds in fact to an equipment lag versus requirements. The investment needed becomes considerable and sometimes difficult to plan for physical reasons, even if the volume of traffic streams justifies it.

.The world economic trend is to develop isolated areas, a prerequisite of which is the establishment of a transport network. The The cost of this network appears in some cases to be out of proportion to the needs to be satisfied and which are known with great imprecision. Investment involves a certain amount of risk, plus its cost, account taken of the location of the regions to be developed and their conditions of access.

In any case, it may be observed that there is : /7

.a diversification of transport missions which can no longer be accomplished satisfactorily by existing facilities.

.some physical limitation (or great difficulty) facing the development of existing land facilities.

.a generally high cost, and sometimes disproportionate with the needs to be satisfied, of the investments required to meet the often risky needs.

The dirigible technique appears likely, in some cases, to meet the problems which cannot be solved by traditional means of transport.

In the field of aerial work, there is also a growing diversification of missions which cannot be fulfilled by traditional means.

If fact, the operations of aerial work are planned in so-called sensitive zones where the construction of surface equipment cannot be considered for purely physical reasons, for financial reasons, and for ecological reasons.

In most cases, aerial missions require the presence of a platform, mobile or immobile, the cost of which must not be excessive (which is likely to be the case for the helicopter), and the ground construction of which cannot be considered for the reasons presented above.

The dirigible technique appears to be, in a large number of cases, the solution which is technically and financially acceptable.

1.1.3. The Constraint of Environment /8

The renewal of the concept to use the dirigible for transportation and aerial work was developed in a context favorable for its use of which some of the aspects are presented below :

Energy Savings

Contrary to most of the other means of aerial transport, the energy required for the dirigible shall be used for its translation and not for its lifting force. Hence, the use of the dirigible is interesting from the point of view of energy.

Space Requirement

The dirigible shall make use of generally very little space in the lower atmosphere for transport and aerial work, except when in the proximity of airports, there is less space used for surface equip ment without taking up space at higher altitudes, which is reserved for the airplane.

Noise

If the dirigible is still motorized, the noise pollution results from the translation motorization and not from its lifting force. Furthermore, the small weight constraints should make it possible to use less costly noise reduction techniques for dirigibles than for the airplane.

Environmental Protection

Some requirements for the protection of the environment and of the sites will result in the application of methods of construction, development, supervision, etc ... which are not too costly, but which doe not require the construction of ground facilities for transportation; hence, the dirigible becomes interesting.

Software Technology

The dirigible may be considered at least partially the result of a software technology.

Considerable Increase in the Need for Transportation and for Aerial Work

This increase is partially due to isolated regions and countries with little surface transport facilities. Since the dirigible, like the airplane, does not require continuous ground equipment, it appears to be in areas which are deprived of or are poorly provided with means of surface transport, an economically feasible alternative, even when the operating costs are high.

Accordingly, vast zones are available to the dirigible, particularly in the tropical and equatorial zone, and even in the polar zone.

Need for Fast Regional Development /9

In many cases, the development of a region is held up by delays in the construction of surface transport infrastructures which can only be built in advance (roads, railways) or which require considerable means (sea ports, airports).

In its principle, the dirigible does not require any substructure, or requires only a small substructure to accelerate the construction of surface transport substructures and to assist in the immediate organization of commercial transport systems.

1.1.4. Problems to be Solved /10

Even though the dirigibles have already flown and the technologies applied for the construction of the dirigible are already known and tested, numerous problems still remain to be solved and they are pointed out below.

Among those which were pointed out most frequently during the survey, we should mention :

Problems Relating to Meteorology

The most frequent remarks made relate to :

.the possibility of flying in frost conditions
.the possibility of wind resistance, either while in flight (the velocity of the dirigible must permit it to avoid perturbed zones), or while on the ground (the berthing system must be adequate to avoid any breakdown).
.the risks arising from snow accumulation
.the risks arising from lightening
.etc ...

The military, for example, shall require of the dirigible to endure any weather condition. In all cases, a low altitude meteorological forecast must be viable.

Problems Relating to Aircraft Controllability and Positioning

The most frequent remarks made concern :

.the actual possibilities of stationary flight and the cost of stationary flight.
.the possibilities of loading and unloading freight without landing.
.the controllability in the case of flight at low velocity.

Problems Relating to Ground Equipment

The most frequent remarks made concern :

.the type and amount of minimum substructures required for loading heavy and bulky cargo.
.the handling systems to be considered (on ground or on board).
.the compatibility with other air vehicles (air traffic control).

1.2. COMPETITORS OF THE TRANSPORT AND AERIAL WORK DIRIGIBLE /11

The dirigible used for transport and aerial work is integrated in a system of activity where it is likely to compete with a very wide range of techniques employed not only in transportation, but also in handling, telecommunications, construction, excavation, agriculture, etc ...

In the paragraphs below, we have attempted to characterize the diversity of this competition, by underlining the main features and by indicating, for the sake of examples, various markets and missions where competition would be probable :

1.2.1. Competition with other Techniques of Transport

Competition with other transport techniques is generally with regard to investment and to operation. Furthermore, in numerous cases, each technique should be placed not only within the framework of the transport system, but also in the one of a territorial economic development system, ... which is much broader.

With this in mind, the main competing techniques are the following :

Passenger or Livestock Transport System

This competition will mainly play a role in sensitive areas (mountain, forest). In many cases, the transport of passengers and of livestock shall already by substituted by other techniques, which are either imperfect (road transport), or costly (helicopter).

Example :

The establishment of construction materials in mountainous areas, forests, swamps (shelters, television relays, high voltage lines, continuous transport infrastructures, etc ...).

Railway Transport System

When infrastructures exist, and there is no need for discontinuity in the flow of transport, competition shall play a role only for exceptional transports (outside the lifting force of highway structures, or beyond clearance) requiring the construction and operation of special cars. In the contrary case, account should be made of the effects of a continuous transport infrastructure on the economic development of the regions crossed and vice versa of the construction delays of a railway infrastructure.

Example :

Establishment of turn-key factories, of atomic plants, agricultural development, etc ...

Road Transport

The terms of comparison are the same as for the railway transport system, in the case of an existing infrastructure as well as in the case of an infrastructure to be created. The cases of load flow discontinuities are less numerous, account taken of the diffusion of the road transportation, but the risks of saturating the network are greater and faster. The period of time required for the establishment of a highway infrastructure is long, especially in the case where a heavy network is constructed.

Example

Opening up continental regions, fast development traffic networks (Europe, Middle East, when surface equipment is "not up-to-date", exceptional transports, transport of hazardous materials.

Water Routes

Since water-way transport is particularly economical, there is competition only in the case of exceptional transports, and when the flow of the load is discontinuous. The diffusion of the river network is small and its possibilities of expansion are limited.

Example :

The transport of indivisible loads, of heavy freight, when load flow discontinuities are costly.

Sea Routes

Since the transport by sea is particularly economical, there is competition only in the case of discontinuous loads or when the distances travelled are considerably reduced, both for transports of indivisible masses and for transports of heavy cargo or containers.

Example :

"Turn-key" factories, or the transport of heavy or semi-heavy cargo from or toward isolated regions (cotton of Tchad) : indivisible masses in the case of transshipment difficulties.

Air Transportation by Plane

The cost per t/km is very high versus other techniques of transport. The transport by dirigible will be necessarily more economical and will be more suitable in every case where speed of the transport shall not be the essential criterion for selection. Heavy air cargo transports require large ground structures, which are therefore costly and not widely spread, making it necessary for traffic flow discontinuities.

Example :

Opening up isolated regions, supplies for assembly lines (automobiles), etc ...

Air Transportation by Helicopter /13

The cost of transportation by helicopter is very high and its commercial load is limited. In cases where conditions require the use of the helicopter (transport in sensitive areas), the same conditions are also conducive for the use of the dirigible.

Example :

Transportation of various materials, prefabricated parts, containers, logs, etc... over short distances.

Teleferic

The teleferic generally has one function, and that is the evacuation of raw materials. Except for special cases, it returns empty, and does not allow for the conveyance of passengers over long distances.

With an equivalent cost-price, the dirigible allows for the development of underserved regions without costly investments which cannot be made in regions without economic rescurces.

Example

Evacuation of minerals in arid zones or areas without economic resources.

Conveyance by Pipeline

Conveyance by pipeline is by definition in one direction only and strictly specialized. It has no interest for the global development of the region served or for the development of intermediary zones.

Example

Petroleum evacuation from isolated zones, gas conveyance to prevent flow discontinuity and gas liquidation.

Miscellaneous

There may be competition with new techniques such as the air cushion (transportation combined with handling operations over short distances, transportation of vehicles accompanied or not over high traffic routes), the water cushion (transportation combined with handling operations over short distances), etc ...

Observations

Naturally, when any comparison is made with the dirigible, account must be made of the associations made between transport modes resulting in combined transport operations (RO-RO ships, automobile carrier vans, barge carrier ships, etc ...).

1.2.2. Competition with other Aerostatic Techniques

The transport and aerial work dirigible will be (or is likely to be) in competition with other aerostatic techniques, of which we should mention :

The Free Balloon

The free balloon is neither a captive balloon (absence of cable) nor a dirigible balloon (absence of motorization). It moves vertically through its own weight, balanced more or less by the Archimedes thrust. It moves horizontally by the wind; certain aerodynamic shapes provide it with a certain dirigibility.

The free balloon is interesting :

.from the purely sports point of view
.from the point of view of scientific space exploration and geographic ground exploration (farm, mining remote sensing, etc ...).

The Captive Balloon

The captive balloon rises through the Archimedes thrust, but is held to the ground by a cable (which in some cases may have other functions : energy supply, collection of scientific data, etc ...).

The captive has serious disadvantages with regard to air traffic (this disadvantage in peace time was used as a means of air defense in wartime).

Its applications are relatively numerous.

.High altitude (4 to 5000 m) observation platform for science, military meteorology, remote sensing, etc ...

.Military or scientific observation platform at medium altitude

.High altitude radar, television, radio relay platform

.Low altitude publicity platform

.Fixed altitude anchoring point : photography, construction, setting atomic device, pollution control, parachute dragging platform.

The Semi-Captive Balloon

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The semi-captive balloon has two very distinct forms :

Dirigible balloon which is likely to be ground anchored to perform certain handling operations (port handling, building construction, electrical pylon construction), in the case where it appears to be necessary to have a fixed anchoring point at a certain altitude.

Balloon (dirigible or not) sliding along a cable (setting of excavation devices, unloading ships, evacuation of lumber, mining extraction.).

The Geostationary Balloon

The geostationary balloon is a vehicle maintained in the stratosphere at a fixed point versus the ground by means of a dynamic anchoring.

It applications may be numerous : telecommunication relay, television relay, scientific observation platform and, particularly, astronautic observation platform, etc ...

The Towed Balloon

This is a non motorizd balloon, the use of which has been considered for the transport of gas and particularly of natural gas (Battelle project of non motorized balloon towed by a small dirigible) or for surveillance (non motorized balloon, towed by ship, to protect convoys in wartime).

The Hybrid Dirigible Ballon - (Helicopter - Balloon Combination)

This type of device has been considered to ensure aerial work missions in competition with the helicopter or with the dirigible : the role distribution between the "helicopter" system and the "balloon system varies according to the projects.

This type of device may be considered for aerial work missions (forestry, handling of containers, assembly of prefabricated buildings or metal structures, etc ...) or for surveillance and transport missions.

The Dirigible On Air Cushion

This is a device which combines two techniques permitting transport and handling missions over watery surfaces, for example, over variable distances.

Lightened-Aircraft

Combination of balloon and airplane, giving it both the advan-

tage of the lightening effect secured by the use of helium and the device remaining slightly heavier than air and the ground control capability of the airplane. /16

Projects studied by AERON CORP relate to :

.One observation platform (65 to 195 km/h - crew of 3)
.One conveyor with medium freight (240 km/h - 160 tons over 1600 km)
.One heavy freight conveyor (240 km/h - 300 tons).

1.2.3. Competition with Techniques Other Than Transport Techniques

Aerostatic techniques enter into competition with other numerous techniques of which a complete list cannot be given. Let us mention among them :

Satellites

Likely to fulfill the role of relay for communication, television, observation platform and remote sensing (meteo, farm resources, mining, pollution, water quality, etc ...).

Ground Facilities

For technical reasons, they are established on elevated sites, which makes it difficult to reach them (observatory, television relay telecommunication relay).

Ground Handling Processes

Cranes (harbours, buildings and public works), means for side handling, air cushion, water cushion, etc ...

In the widest meaning of the term, competition is more than just substituting one technique for another technique.

The dirigible can, for example, be integrated in a manufactruing procedure (refer to the transport of spare parts to supply an automobile manufacturing line) or it can sustitute other types of activities (cruises in dirigibles can take the place of a hotel stay).

1.3. MISSIONS WHICH ARE LIKELY TO BE ASSIGNED TO THE DIRIGIBLE /17

Considering what has been stated up the the present, a large number of transport and aerial work missions may, theoretically, be assigned to the dirigible.

We should not lose sight of the fact, however, that in many cases, the dirigible shall be integrated into an existing transport network, which is complex and sometimes complete ; in this case, it may be taken into consideration :

.To the extent that it shall provide a better cost (including depreciation) and/or better service than the other means of transport.

.To the extent that it shall provide a new service that the other modes cannot give, either due to the types of products to be conveyed (indivisible masses, for example), or to the inadequacy of the infrastructures or to the means of conveyance itself, or to the investments to be provided for improvement or for technical difficulties encountered for the improvements (sensitive zones).

.Finally, to the extent that the additional cost resulting from the use of the dirigible shall lead to improvements in the conditions of transport (reduction of time limits, for example).

In the case of a zone lacking a transportation network, the possibility of using the dirigible shall be taken into consideration only after a comparitive study between the various modes of transport which are possible by taking into account the investment and operating costs (infrastructure and equipment) required together with the advantages of the modes studied (services provided) along with the indirect advantages resulting from their operation (development of the areas served and crossed, impact on environment, etc ...); these advantages are naturally very difficult to estimate.

With these considerations taken into account, the presentation below reviews only the types of missions which could be assigned to the dirigible and the reasons for making the choice.

1.3.1. Transportation of Goods

The conveyance of goods by dirigible may be considered :

.Due to the type of goods transported ; when the conveyance by other modes is difficult : weight, dimensions, rate of deliveries, hazardous nature of the product, etc ...

.Due to the "sensitive" characteristic of the zones to be crossed (mountain, forest, swamp, urban), which induces a high cost of the infrastructures or of the operations proper of the transportation. /18

.Due to the high cost of the transportation "chains", causing other modes of conveyance to be brought in, which result from the intrinsic cost (airplane) or from discontinuous transports.

.Due to the possibilities of integrating the transport by dirigible into a manufacturing process.

1.3.1.1. Type of Goods Tranported

The goods which are likely to be assigned to the dirigible have, in today's situation, characteristics which create difficult problems or are costly to solve when assigned to other modes of transport.

These goods may be classified as follows :

.Heavy and Indivisible Loads

In all fields, there is a trend toward giantism, which results in the industrial field especially from fabrication in the factory, which proves to be economically and technically more interesting than assembly on the site, from inter-firm cooperation resulting in the preparation by the various partners of bulkly or heavy sub-units, (case of aeronautical construction), from technical progress stimulation projects to become more ambitious (marine platforms, high-rise constructions), from the fact that pegging out sites are often far from the construction sites, from the fact that these pegging out sites tend to become farther away from the traditional sites of acces, such as the sea ports (nuclear plants).

These trends result in often considerable increases in the weights and dimensions of the products produced in the factory and in transit, for example, in sea ports.

In this situation, it appears that in spite of the efforts made by the various techniques of transport, the displacement of heavy and indivisible loads constitutes a permanent bottleneck, and the progress made in the area of infrastructure (specialized road itinerary, reinforcement of highway structures, for example), in transport devices (special cars made for a single type of transportation), in handling devices (transporters, sheer-legs, water or air cushion, etc ...), do not allow for all the benefits which could be drawn from technical and industrial possibilities.

Furthermore, it appears that the conveyance of heavy loads /19
and indivisible loads is not, in principle, repetitive : investments for infrastructures and means of transport are likely to be made for only one operation or for a limited number of operations ; their depreciation must be provided for a single operation of transport or for a limited number of transport operations.

The use of air routes by means of the dirigible solves the problems arising from the use of surface routes (clearance, handling equipment, bearing capacity of highway structures) and also allows for a depreciation on a large series of transports, since the dirigible is not attached to an infrastructure, especially if it can be stationary.

The demand pressure is such that if a means of transport made it possible for industry to no longer have to consider the constraints of weight and bulk, the weights and bulkiness of so-called packages would have a tendency to increase fast, which would confirm and accelerate the current trend.

.Light and Bulky Loads

The dispatching of less than 50 ton presents no serious difficulties to the extent where the bulk of packages remains within the

prescribed clearance limit of surface transport routes, and to the extent that a large number of load discontinuity points are equipped with adequate handling equipment.

There are nevertheless numerous cases where :

.even though the limits for "light" loads are adhered to, i.e. 5 to 50 tons, the dimensions of packages exceed the clearances currently allowed by surface transports and require the use of either special transport devices, or the use of specialized itineraries, or a combination of both : vessels and tank, radio-electric equipment ; this problem may come up not only for exceptional transports, but also for regular traffic streams (steel sheets, for example, prefabricated parts).

.the dispatching of average weight packages presents difficulties arising less from the exceptional characteristic of the dispatch than the frequency of the dispatches (supply of one site like the one in Tricastin, of large dams during the construction phase, construction of pipe lines, etc ...).

Finally, it must be assumed that the possibility of transporting bulky loads by air would lead to transfering to the factory some of the manufacturing operations currently carried out at the site.

.Heavy or Semi-Heavy Products /20

When the overall account of a transport operation or system takes direct as well as indirect costs into account, the transport by dirigible may be considered. Even though it is expensive, it has advantages with regard to :

.The congestion of other networks (the intensive operation of a quarry may result in an unacceptable congestion for the environment of the highway system ; the development of the highway network would cause investment expenditures at a level which would allow air transport to become competitive again).

.The development rate of a site (transport of materials to sites such as the airport of Nice or to the Port of Antifer has had a considerable effect and the supply rate has to a certain extent controlled the overall rate of the site. An air transport would have modified this rate by having a less perturbing effect on the environment.

.The reduction in surface investments : the supply and evacuation of the paper-pulp factories in Guiana (under project) has been considered by land route as well as by air route (dirigible) through the use of a landing point located on an island along the shore of the Guianese coast.

.The possibilities of opening up and developing economically : some mass transport needs must be considered for several reasons.

Surface transports must satisfy : the evacuation of cotton, of agricultural food products. The fact that heavy cargo planes are used, in spite of the cost, is an indication of the possible market for dirigibles as a means of transportation, which is slower, but less expensive.

.Providing supplies to sites in hostile areas : construction of dams in Latin America, site in the Near East, construction of buildings in Siberia, etc ...

.Direct transport permitting load discontinuities to be avoided and permitting simple rather than complex itineraries to be followed.

.Safety : the transport of chemicals and hazardous products by road or railway leads to the use of special itineraries and, possibly to the establishment of a civilian protection system which is expensive. Conveyance by dirigible along air routes which are not above inhabited zones may be considered.

.The cost of transport infrastructures for immediate use, in the case of the construction of linear infrastructures : the supply of /21
pipe-line construction sites, railways, teleferics, of high-voltage lines may be carried out by dirigible, which permits a continuous supply, without road construction of the various construction sites, by avoiding an "advance" infrastructure construction which increases the time required.

.Containerized Goods

The use of containers along the most f equently traveled sea routes (North Atlantic) is now an established fact. It is accompanied on the one hand by handling equipment for the largest ports and by a partnership policy with road and railway transports to provide for a combined transportation system.

Generalizing the transport of containers through all international trade streams is slowed down by the need to equip a growing number of ports with handling equipment which is likely to be underused, and by gaps in the surface network in the back-country of the ports. The possibility of using container-carrier dirigibles either permanently on board container-carrier ships, or in a zone where ports are sparsely or poorly equipped, appears to be a solution to the current two-fold problem without multiplying the investments.

.Petroleum Products (Natural Gas)

The conveyance of petroleum products requires the creation of a considerable infrastructure : the balloon filled with gas, towed by a dirigible was a solution researched, along with another solution of partially filling the balloon with gas.

.Vehicles

The vehicle carrier dirigible may be considered :

.for the transport of new vehicles loaded ex factory and transported to destination.

.for the transport of vehicles when crossing straits (The Straights of Dover, The Straights of Scandanavia, Japan, etc ...).

.for the transport of trucks or semi-trailers in order to avoid congested ports of delivery or difficult traffic zones : in the Midle East, where the sea transport of semi-trailers is expanding, the dirigible would be able to go to the interior of the country of destination and thus avoid congested ports and zones of difficult access.

1.3.1.2. "Sensitive" Characteristic of Zones Crossed Over /22

In the case of transports described above, crossing over "sensitive zones" increases the interest for the dirigible to the extent where the development of an adapted transport infrastructure and where transport operations are difficult, if not impossible, or are too expensive.

By sensitive zones, we mean :

.rough areas, especially in the case of scattered transport requirements which do not warrant the establishment of surface infrastructures (forestry in Europe).

.swampy areas which make it impossible to create a surface transport structure (forestry in Africa, economic development of Siberia, the Amzonas).

.areas which do not warrant an economic development through the establishment of a continuous infrastructure (deserts, uninhabited forests, regions which are frozen most of the year).

.areas requiring a discontinuous transport system per unit of surface.

.urban areas where infrastructural improvements are difficult due to cost or environment.

.areas with satruated surface transport infrastructure.

1.3.1.3. High Cost of Competing Transport Chains

The cost of a transport results from adding the basic transport cost, the cost of annex transport operation (handling and load flow discontinuity), the depreciation cost of infrastructures (reflected or not reflected, or partially reflected on the overall transport cost), financial charges (fixed capital) and supplementary expenditures or reduced expenditures (packing, special vehicles) incurred from the use of one mode or another.

Under these conditions, any comparison must reflect in the overall costs and in the overall services rendered by the technique of transport under consideration..

In a case like the one relating to the supply of the manufacturing plant in Nigeria, air transport was selected in spite of its high cost, because the reailway (or road) transport chain in Europe, sea route in Nigeria did not offer enough guarantee o' safety (risk of loss) and regularity (due to port congestion, to the poor condition of the road network and to the psychology of the local drivers).

The speed offered by the airplane is important, but excessive : /23
the substitution of the heavy cargo plane (which has problems with return freight) by the dirigible, which is slower and less regular, would be an acceptable solution to the extent that it would be less expensive : at the present time, the Peugot Company is planning to relocate the take-off point of planes toward an airport located to the South of Lyon and to use B.747's in order to reduce the overall transport cost without extending the flight time.

In the assumption of using the dirigible, terminal transports could be reduced or eliminated, due to a direct access to the factory and to a loading of return freight (bulk goods, cotton, etc ...). This would be undoubtedly easier to consider, account taken of the transport cost by dirigible. The overall account aould thus be favorable to this type of transport.

In a case such as the one given for the Middle East, the cost of road transport is increased by charges incurred from crossing Turkey and the time required is increased by adding waiting periods at the borders and by a congested network ; the cost of maritime transport is increased by harbor docking charges and door-to-door conveyance is costly in investment and in time ; furthermore, the harbor handling operations are difficult and expensive.

The dirigible may also be considered to the extent where it reduces annex operations and allows for more regularity.

1.3.1.4. Modification of the Industrial Manufacturing Process

Transportation, in some cases, may be intricately integrated into the manufacturing process of a product. We may refer to the transport of concrete by road system, the transport of iron smelting by railway, the period of time required during sea transport for fruit to ripen.

In the case of the Peugot automobile manufacturing at Kaduna (Nigeria), the airplane is used as a means for continuous supply for and assembly line, with the bladed sections arriving at their destination already sampled, so that it is not necessary to provide a large and systematic storage, except for safety storage, to ensure the final automobile assembly.

The outline adopted between Sochaux and Kaduna may certainly be repeated. The cost of the transport system, however, is high because of the use of the airplane, and the results obtained relating to speed, for example, are higher than strictly necessary when regularity is the most important quality sought after.

This is why the dirigible is suggested, it is slower than the airplane, but faster than for surface routes. It is nevertheless adequate and is coupled with a good regularity along with the capability for loading and unloading in the immediate proximity of the factories (resulting in a reduction in problems caused by storage at the airports, discontinuities in the load flow, and by road prerouting and rerouting. /24

If this type of transport plan can be considered over long distances within the framework of a country with inadequate means of transport, perhaps it can also be considered in developed regions in order to avoid a multiplication of road transports which generate a congestion of the road network. The dirigible may hence be used for the transport of heavy parts and bulky products, the assembly of which shall be carried out in the factory and not at the site. It may also be considered for the transport of bulky components prepared in the factory (pylons), whereas the assembly at the site is difficult and more costly. Finally, the dirigible may be considered for the systematic transport of components prefabricated in the factory (building), etc ...

1.3.1.5. Inventory of the Missions /25

We have presented below an inventory, which if not exhaustive, is as complete as possible regarding transport missions of goods, which we may reasonably consider assigning to the dirigible.

This presentation is naturally only a rough draft, but it permits nevertheless the essential characteristics of the devices used to fulfill these missions to be delineated. A more detailed description of a certain number of missions has been reported in chapter 2.

Transport of Heavy and Indivisible Loads

The transport of heavy and indivisible loads presents difficult problems to be solved by surface transport means exceeding 250 tons used in countries with a developed surface transport infrastructure and often beyond this tonnage in countries having a limited surface infrastructure.

This traffic is growing constantly, as is demonstrated by statistics and the opinions of port authorities. Heavy and indivisible loads are frequently in transit in ports and as a result, the handling equipment is becoming more and more elaborate.

The sectors where these transports are expanding are as follows:

Power Plants

Development programs involving thermal and nuclear equipment are of interest to most countries, whether industrialized or not, the construction of a plant requires the transport and the setting into place of 5 or 6 boxes containing between 250 and 500 tons (and a

large number of boxes with less tonnage) and quite often the possibility of transporting these few boxes conditions the possibility of constructing the plant on the site selected.

The currently used transport systems imply the use of a road (an (and sometimes railway) transport, of a river and sea transport and require the use of handling equipment (travelling cranes, mast cranes cranes) which are very powerful. The cost of a transport operation varies considerably according to the itinerary set by the site.

The dirigible may be considered for door-to-door transports or for transports between the factory and the specialized sea ship and for the transport from the ship to the final site, which means there is a very wide variety of radius of action.

The installation may be carried out by the dirigible itself, provided that it can be positioned and remain in stationary flight.

The fulfillment of this type of mission leads to the following specifications :

Average Weight : 250 - 500 tons (more later on)

Radius of Action : 1000 to 2000 km (a wider radius of action may be considered if the entire transport is assigned to the dirigible)

Velocity : 100 to 150 km/hr appears to be adequate

Note : Stationary flight and vertical landing are required

Turn Key Factories

The industrial equipment programs of most countries lead to the delivery of turn-key factories, the components of which are fabricated in the supplier industrialized countries. This traffic is expanding rapidly, and for its transport, the factory is conditioned by a certain number of "boxes" with variable tonnage.

The transport difficulties depend mainly on the site of the industrial location of the factory and the transport is carried out by rail and road routes combined with sea and river transport, which require, in general, discontinuities in the flow of the loads, resulting in the requirement for substantial port equipment and handling equipment for ships. The size of the boxes along with the weight is variable,but in general, the weight doesn't seem to exceed 250 to 500 tons.

The same observations as in the preceding case may be made for the radius of action. On the other hand, it may be assumed that the stationary flight is not indispensable, except in the case where the loads are to be loaded or unloaded directly from the dirigible to the ships. Short take-offs on unprepared ground should generally be adequate.

The accomplishment of this type of mission leads to the following specifications :

Average Weight 250 - 300 tons (more later on)

Radius of Action 1000 to 2000 km (a considerably higher radius of action may be considered, if the entire transport is assigned to the dirigible)

Velocity : 100 to 150 km/hr appears to be adequate

Note : Short and vertical landing

Off_Shore_Equipment /27

Off shore oil drilling (and over the next decades, the installation of various equipment in the coastal economic zone of 200 miles) requires the transports of considerable tonnage and numbers of indivisible masses. These transports are carried out by towing (platform) or by maritime transport, departing from assembly centers which must be located along the sea.

The helicopter is also used, but its use is limited due to its commercial load.

The dirigible may be used for the transport and assembly in situ of the platforms. The radius of action may be limited to 1000 - 2000 km, but the construction constraints and the installation require the flight to be stationary.

Furthermore, the meteorological conditions are likely to be restricting and very quickly changing. The weight of the box to be transported is very variable depending on the techniques of construction. A drilling "islet" weighs 45 000 - 50 000 tons with sub-units of more than 1000 tons.

The accomplishment of this type of mission leads to the following specifications :

Average Weight : 250 -500 tons (possibl more)

Radius of Action : 1000 to 2000 km

Velocity : 100 km/hr appears to be adequate

Note : Stationary flight and vertical landing
The aircraft shall encounter very constraining meteorological conditions ; it shall be used in the platform construction process.

Mining Equipment

Mining and quarry equipments make use in some cases of very

large tonnages (excavators, tri installation, etc ... . A travelling gantry component required for the mining center of Narvik and transported by Dunkerque, in 1976, weighed 450 tons). Their transport may be compared with the off shore equipment transport, except that the distances to cover are longer and the meteo conditions are more predictible ; but the operation of a mining site may be considered without creating a road network or railway network (evacuation by teleferic or pipe-line).

In any case, the transport by air of the mining equipment can accelerate the working of the size, even if, later on, a surface network is created.

Average Weight 250 tons (possibly more)

Radius of Action 1000 to 3000 km (the transports are currently ensured from the port zones ; with the dirigible, they can be ensured from the interior the factory)

Velocity : 100 km/hr appears to be adequate

Note : Vertical Landing (or short on prepared ground)

Prefabricated Components for Boats

/28

For economics reasons and with the aim to improve the working conditions (work under shelter), some naval ship building yards are beginning to build large tonnage boats in sections, which may weigh several hundred tons.

The handling of such components, either inside a port or between several ship building yards presents difficult problems to solve by traditional means.

This mission may be carried out by dirigible meeting the following specifications :

Average Weight : 250 - 500 tons (possibly more)

Radius of Action : A few hundreds of km; or a few km

Velocity : 50 to 100 km/hr

Note: Stationary flight and vertical landing

Aerospatial and Aeronautical Prefabricated Components

Two types of transport have in this area lead to the elaboration of projects or to the implementation of "special air vehicles" : the transport of rocket components (which were at the beginning Goodyear projects, of which one, Air Transporter, was designed to convey large tonnage boats in sections, which may reach several hundred tons.

a commercial load of 275 tons) and the transport of fuselage components for airplanes. In the case of a conveyance to the assembly plant, the use of the Super Guppy points up to the interest for an exceptional transport vehicle, but the transport characteristics of the dirigible used for this purpose are variable with respect to the tonnages and radius of action, which depend on the industrial relocation of factories respnsible for the manufacture of sub-systems. We can imagine that when there is a cooperation between European and American aeronautical industries, the radius of actions required is about 5 to 6000 km.

The specifications could be the following : /29

Average Weight	100 to 250 tons
Radius of Action	2000 to 6000 km
Velocity :	100 to 150 km/hr
Note :	Short Landing

Ships

The transport of ships, which cannot confront the high sea and the tonnages of which may reach 100 to 200 tons, to either inlands seas or to lakes, or to distant locations present difficult problems to be solved. Such operations are relatively frequent. At Anvers, for example, (Trinity House boat of 130 tons (30 X 8 m X 8 m).for inland water routes in Indonesia.

The specifications could be the following :

Average Weight	100 to 250 tons
Radius of Action	1000 - 2000 km (possibly more)
Velocity	100 to 150 km/hr
Note :	Vertical landing and stationary flight

Components of Highway Structures

The construction of highway structures (bridges, in particular) implies the transport and installation of sub-assemblies weighing several hundreds of tons, which are often assembled on the shore. This explains the importance for having the construction site on location, destruction of banks, installation of handling equipment for land or water, etc ...).

The construction of structures, such as estuary viaducs (French estuary, Scandinavian straits, Bay of Rio) could be carried out through the use of dirigibles, for which the specifications should be as follows :

Average Weight	250 to 500 tons (possibly more)
Radius of Action	A few hundreds of km
Velocity	50 to 100 km/hr
Note :	Vertical landing and stationary flight

The list below cannot be exhaustive. Nevertheless, it underlines the diversity of cases where the transport of heavy and indivisible masses condition the implementation of a project. /30

In such cases, it is often the transport of heavy parts which requires substantial additional investments (road improvements, bracing of bridges), whereas the other boxes can be dispatched by traditional routes. To the extent, however, that investments for dirigibles would be made, it could be added to the marginal cost of other boxes in better conditions than the other surface transport techniques.

Transport of Light and Bulky Loads

If the transport of heavy and indivisible loads has problems which are increasing rapidly because of industrial and technical developments as well as from hesitations of the administrative service in charge of roads, there is also a large market for the transport of packages which weigh several tens of tons (even a few tons). The bulk characteristics, however, measured in comparison with existing infrastructures (or necessary ones) are excessive, especially when these transports are repetitive and result in the congestion of the road or railway network, or when they take place in regions without a transport infrastructure or with an inadapted one.

We have listed below a few sectors where such transports have had an actual economic impact. It may be observed in many cases that the "light" objects and bulky ones may be grouped in order to obtain loads weighing several tens or several hundreds of tons.

Forestry

This market has been studied by :

.Aérospatiale, in connection with le Centre Technique du Bois (Technical Wood-working Institute) has prepared a rough draft on the Forest Helicostat. These studies have been conducted mainly for application in the European forests.

.TRANSCONSULT at the request of several forest-rangers and the ONERA, which has lead to the determination of needs in the equatorial zone.

These various studies shall not be repeated below, we shall review only the main project cards.

Forest Helicostat

.Hybrid device between the helicopter and the balloon
.Lifting capacity : 2 tons (at 1800 m and by 20° C)
.Twin engine machine (for safety reasons)
.Good controllability
.Good vertical visibility
.Minimum bulk and effective ground anchoring system

.Rapid loading device
.Capability of transporting tree chopping equipment and personnel
.Easy maintenance
.Cost lower than for the LAMA helicopter

Operation at Equatorial Site

.Average weight 15 to 20 tons (making it possible to treat almost all the trees)
.Radius of action : the distances to be covered shall range from several kilometers to several tens of kilometers, but it would be necessary to expect one or two refuelings per day.
.Use in tropical and equatorial atmosphere
.Stationary flight
.Efficient, reliable & rapid handling system
.Efficient ground anchoring system

The helicostat and the device used in equatorial regions have the function of grouping the chopped trees on a main transport system (road or river) : they perform, then, the removal and discharging operations which are the most costly and which are carried out by helicopter or caterpillar tractor.

The transport of wood in larger quantities and over longer distances is studied later on.

The Supply of Civil Engineering Linear Construction Sites /32

Under this title, we can group the construction of electric lines, railways, pipe-lines, which generally require the construction of service routes, the cost of which is sometimes high, particularly in hostile areas, but also in regions with crops, since the cost of indemnities paid to the landowners tends to increase rapidly.

Furthermore, the cost of personnel engaged at the construction site (welders for the pipe-lines, pylon layers) increases at a fast pace, and there is a lack of this type of specialized personnel.

The construction of High Voltage Lines

At the request of the ONERA, this subject was researched by TRANSCONSULT in connection with EDF and the main French manufacturers. The following possibilities have been considered :

1° The dirigible is used as a means for transporting personnel and equipment to the site of pylon relocation from a storage center located on the rail route (developed country).

Summary of specifications :

Average Weight : 15 tons
Radius of Action : Rotation of several tens of km maximum, but refueling to be provided once or twice a day.
Velocity : 50 km/hr
Note : Vertical landing and or stationary flight

2° The dirigible is also used as a means for lifting the pylons
Specifications summary :
Same characteristics, but stationary flight is indispensable

3° The dirigible is used as a means for handling the pylons /33
which are to be assembled on a storage area or in the factory.

The construction sites could be supplied with 15 tons by dirigibles as is specified below :

Average Weight 30 to 75 tons
Radius of Action 500 km
Velocity 100 - 150 km/hr
Note : Stationary flight with very close landing accuracy

The construction of Teleferics

This takes places particularly in areas lacking a surface transport infrastructure and is confronted by problems which are similar to those encountered for the laying of the high-voltage lines, with the difference that the equipment storage centers are farther away.

The characteristics of a dirigible adapted for this type of transport should be as follows :

Average Weight : 30 to 75 tons
Radius of Action : 500 to 750 km
Velocity : 100 to 150 km/hr
Remark : Stationary flight

Pipe-Line Laying /34

Pipe-lines, in particular are confronted by difficult and long problems to be solved, because the relocation sites (desert areas in the Middle East, frozen zones, swampy areas, etc ...) are characterized by extremely difficult working conditions which result in high costs.

The supply of a construction site requires the construction of service roads, which have only a temporary use, but which must be able to carry high tonnage trucks. Construction camps and storage centers must also be established. Moreover, due to the capacity of the transport devices, short tube sections must be provided.

The Russians have developed the concept, through studies, of welding sections of 100 m in the factory, which shall then be transported by dirigible together with other equipment and personnel.

Furthermore, air transport shall make it possible to accelerate

the operation at the construction site, since the laying procedure does not have to be carried out in advance.

The specifications for a device adpated for this type of transport should be :

Average Weight	100 to 200 tons
Radius of Action	500 to 2000 km
Velocity	100 km/hr
Remark	Stationary flight

Marine pipe-line laying is confronted with problems of a very different nature due to the very specialized marine equipment which is required.

The dirigible, with the characteristics presented above, would be used to supply the laying ships with tubes.

The Construction of Railways

A construction s[illegible] with a difficult access is confronted by problems which, if not [illegible]entical, are comparable (transport of personnel, excavation device[illegible] rail equipment and components for highwy structures which can [illegible] assembled at the site, or in the factory, or at one end of the rai[illegible]y, such as at the port, in better economical conditions.

A dirigible with the above characteristics may also be consi- /35
dered :

Average Weight	100 to 200 tons
Radius of Action	500 to 2000 km
Velocity	100 km/hr
Remark	Stationary flight

The Supply of Point to Point Civil Engineering Construction Sites

Besides the regular transport of heavy products, which will be studied later on, the operation of large civil engineering construction sites requires the transport of bulky materials which exceed the standard road clearance (cranes, civil engineering equipment, transport equipment) on the one hand, metal components, and on the other hand, equipment in large quantities.

The range of the products to be conveyed is very wide and is not only for packages exceeding clearance, but also for materials which require the installation of a costly infrastructure and an uncertain use later on in the case of surface transport.

A list of such construction sites is, of course,impossible to provide, but a few examples can be given :

.The Canadian Army is building in the Arctic 26 runways 2,100 m long which are capable of accepting the Hercules. The location of the sites chosen is such that most of the equipment and materials required shall be parachuted. We should be able to find comparable examples in Alaska, in the Soviet Union, and in Brasil, etc ...

.The construction of the factory in Tricastin shall require, among others, for a single Spanish supplier, the transport of :

-360 parts weighing 16 tons (7.90 m X 5.70 m) departing from Malaga, at a rate of 10 per month.
-360 parts weighing 25 tons (5 m X 5 m X 5 m) departing at Gigon at a rate of 10 per month.
-720 parts weighing 20 tons (4 m X 4 m X 4.5 m) departing from Barcelona at a rate of 20 per months /36
-720 parts weighing 20 tons (5 m X 4.9 m X 4.2 m) departing from Barcelona at a rate of 20 per month.
-720 parts of 21 tons (6.9 m X 5.4 m X 3.6 m) departing from Barcelona at a rate of 20 per month.

The transport of one part or of several parts does not involve any problem which cannot be solved, but the rate (80 per month over a period of 3 years) which requires a continuous supply, the impossibility of storage, discontinuities in load flow (seagoing vessel, barge, road transport) have lead to a research for a continuous supply, without a break in the load flow and requiring only a small infrastructure. These are requirements which only the dirigible can meet.

.The construction of the dam at Itaipu in Brasil is expected to last 10 years and employ a maximum of 10 000 workers (80,000 including family members and businessmen).

The scope of the works is presented in the statistics below :

-Total excavation	:56.6 millions of m3
-Equipment installation	:21.2 millions of m3
-Concrete manufactured at the site	:11.5 millions of tons
-Ciment used	: 2.5 millions of tons
-Wood used	:500,000 m3
-Steel used	:225,000 tons
-concrete used at the beginning in 6 plants located in Brasil and in Paraguay	: 300,000 m3

We should also add the construction machinery and equipment for the public works, the components for the hyroelectric plant which shall include 18 hydraulic turbines and long-distance high-voltage current transport lines.

Even if the period of time required for the construction site must be long, it is still only temporary, since the objective is not

to create a zone of activity near the dam, but to supply electricity distant areas. The use of air transport may be considered for the dam, the factory and for the high-voltage lines.

.The development of the Amazon regions is an objective with wide scope which cannot be summarized by a few figures (15,000 km of road in the middle of the virgin forest, development of 50,000 km of river routes, construction of 125 airports in regions difficult to reach by surface transport, industrial relocation of 10 million inhabitants in areas which are virtually uninhabited and in a completely new village and city system.

The operation of an economical means of transportation, which can be established quickly and does not have a demanding infrastructural requirement, is perhaps the only way to accomplish construction and development results within time limits which are fast enough so that the social situation in the North East does not worsen. /37

The scope of the program explains the interest of the Brasilian government in the dirigible.

.The construction of new cities in areas of difficult acces presents a series of transport problems, which have been solved by the use of the dirigible, in the Soviet Union, in particular (Northern Siberia which is difficult to reach because of climate and type of regions to cross : swamps, taïga, etc ...). Similar problems arise in Northern Canada and in Alaska, in Brasil, in Arab countries and especially in Egypt, etc ...

In these various cases, a choice can be made between a traditional method of construction and supply of the construction sites (development of a surface transport infastructure, generally roads, construction of buildings on the site) and a prefabrication in the factory of components which are transported by air and assembled on location.

The advantages from using dirigibles has been evaluated in the following manner through Russian studies :

-Reduction in periods of time required for construction (due partially because the annual working hours shall be substantially increased) and hence an accelerated capital turnover.

-Modification of construction techniques, hence a considerable reduction in the amount of materials needed for the construction of m2 habitable (about 45 %), which should lead to reductions of required transports and costs.

-Concentrations of construction operations in industrialized zones, hence, the elimination of local construction sites and the alleviation of the rise in costs in the North.

-Use of the dirigible as handling and hoisting equipment (elimination of ground installations).

-Elimination of transport infrastructures, the cost of which is highly increased, due to the fact that they must be relocated on snow-covered and frozen ground.

Some results of the studies carried out by the S. Lazo Polit- /38
technical Institute of Kishiniev and of the Tsiolkovsky Public Dirigible Design Office in Leningrad have been recently provided (January 1975).

They permit a comparison to be made of the costs for the modular construction of various types of buildings of 2.5 and 9 stories by using traditional procedures (transport of materials by road and use of the crane) and by using a dirigible with a 100 ton commercial load capability.

Generally speaking, the use of the dirigible is less costly than traditional means in cases where the distances to be covered exceed 50 km. In working time, the dirigible is more economical in all cases.

Case I corresponds to the use of towed cranes, case 2 corresponds to the use of stationary cranes, and case 3 corresponds to the use of the dirigible.

NOTE RELATING TO THE TABLE ON PAGE 33

The figures in parenthesis (cost column) are given in $ U.S. per square foot.

The figures in the work column are given in hours per m2.

.In many cases, the developments of construction sites imply the transport of materials in large tonnages and over short distances : /40
this is the case of highway construction sites where the materials to be transported are for works ranging from excavation to banking, of port construction sites (Port of Antifer), airports (Nice Airport), rivers (Rhine, Rhône, Moselle, etc ... pipelines).

In these various cases, the transport of materials for the filling operation requires the implementation of fleets of heavy cargo trucks, which require the construction of specialized infrastructures which are no longer useful afterward or which disrupt the normal traffic.

In all cases, there are undesirable effects on the countryside and on the environment.

TWO STOREY BUILDING

DISTANCE	CASE I		CASE 2		CASE 3	
KM	COST	LABOR	COST	LABOR	COST	LABOR
IO	(0.I5)	0.22	(0.22)	0.29	(0.44)	0.I5
20	(0.25)	0.37	(0.39)	0.60	(0.54)	0.I7
50	(0.55)	0.8I	(0.78)	I.I9	(0.55)	0.I8
IOO	(0.95)	I.39	(I.47)	2.30	(0.78)	0.26

FIVE STOREY BUILDING

DISTANCE	CASE I		CASE 2		CASE 3	
KM	COST	LABOR	COST	LABOR	COST	LABOR
IO	(0.30)	0.33	(0.47)	0.47	(0.44)	0.I5
20	(0.53)	0.59	(0.73)	0.72	(0.54)	0.I8
50	(I.I3)	I.25	(I.49)	I.76	(0.57)	0.20
IOO	(I.94)	2.I4	(2.7I)	4.I5	(0.76)	0.26

NINE STOREY BUILDING

DISTANCE	CASE I		CASE 2		CASE 3	
KM	COST	LABOR	COST	LABOR	COST	LABOR
IO	(0.5I)	0.49	(0.32)	0.32	(0.44)	0.I5
20	(0.83)	0.8I	(0.59)	0.58	(0.55)	0.I9
50	(I.50)	I.54	(0.99)	0.97	(0.59)	0.22
IOO	(2.62)	2.75	(I.93)	I.90	(0.78)	0.27

The list above could be considerably extended. Generally speaking, there are large tonnages to be transported and the commercial load selected in the Soviet studies is about 100 tons and appears to be minimum tonnage which could be increased in some cases.

The range of distances covered also seems quite wide, since some conveyances (Nice - Antifer) could be limited to a few kilometers and and could possibly be ensured by a cable-guided balloon, whereas the other distances must cover hundreds, or even thousands of kilometers.

The specifications may then cover a wide range :

Average Weight :	100 to 250 tons
Radius of Action :	500 to 2500 km
Velocity :	50 to 150 km/hr
Note :	Stationary flight

<u>The Establishment of Regular Transport Services For Bulk Or Semi-Bulk Products</u>

The first studies carried out in France by ECOCENTRE related to /41
the use of the dirigible for the evacuation of cotton from Tchad and the supply of isolated regions with various goods in the middle of Africa.

Contrary to what has been researched in the preceding cases, ECOCENTRE developed the concept for a regular long-term service, which justified the creation or improvement of such an infrastructure. Consequently, vertical landing and stationary flying, which are necessarily costly, are no longer indispensable.

The traffic streams which are likely to justify the use of a dirigible, for the transport of large commercial loads, are numerous. (Some examples are studied in detail, in chapter 2. As in all cases, the dirigible should naturally be situated within the context of the over-all transport system.

When there is a railway, road, river, surface transport infrastructure or when the traffic forecast allows for the development of such an infrastructure, the transport dirigible is not usually justified.

On the other hand, when the traffic level is not high enough to warrant the establishment of a surface infrastructure, or when the itinerary considered implies large detours or discontinuous load flows or or long delays, the use of the transport dirigible may be justified.

It is mainly in developing nations where the dirigible is most likely to compete with surface transports.

The dirigible may also be considered, however, in countries with a developed infrastructure, when new traffic, because of the type of product transported (hazardous products), or the amount (evacuation of mining products), or its itineraries (discontinuity in load flow) is likely to disrupt the pre-existing railway or road traffic or result in a congestion of the transit centers. /4

A few diagrams of transports which may be transferred to the dirigible are presented below : /42

.The transport of farm or forestry products from isolated areas.

.The transport of cotton between Africa (central) and Europe : without reaching an excessive cost, as is the case for the transport by airplane, the transport by dirigible, for a cost which is comparable to that for the road transport, makes it possible to avoid the use of successive, diverse means of transport, the delays for transshipment in the ports, the risks resulting from these transshipments, etc ...

.The transport of fruit and other farm products from Africa or Latin America to the Northern Hemisphere : it would be possible in some cases to expand productions (apples in Argentina, citrus in Africa, etc ...), if the transport does not result in a bottleneck.

The allowable periods of time required for conveyance by dirigible are long enough so that the ripening of fruits may be allowed for during the trip and new traffic streams may be established from or toward the interior of continents. Accordingly, the dirigible would make it possible to create production markets (inside Africa or South America) or consumption markets (inside Russia, for example).

.The transport of timber from production areas to ports in the form of logs, or from production zones to consumption zones after a first processing near the production sites.

Contrary to the case just presented concerning the evacuation of timber from European or Equatorial forests, the case here relates to the transport of large tonnages between storage yards and sea ports. A particular prospect for the use of the dirigible has been considered for the supply of chemicals and the evacuation of paper-pulp from the factories expected in Guiana to work the equatorial forest.

.The transport of cereals :

The sea transport of cereals, including sorghum and soya, reached 175 million tons in 1975. This large traffic is ensured by cereal ships, in quite good economical conditions, particularly beween ports with large silos.

It appears, however, that discontinuities in load flows in sea ports and their congestion prevent a continuous conveyance toward consumer countries to take place, especially when isolated countries are involved (Central Africa, for example). This transport is disrupted, for example, by gaps in the surface transport system and by

inadequate infrastructures.

.The transport of chemicals, hazardous or unhealthy products : /43
These transports are generally provided by surface transports in particularly economical conditions ; a systematic study of these traffic streams, however, would demonstrate :

-that some of them bring about a congestion of the road networks if the transport traffic volume is taken into consideration.

-that in the case of hazardous products (chemical, nuclear products), a costly civil protection device must be installed, but it would also disrupt the entire general traffic.

-that the evacuation of some products (wastes from Alsacian potassium mines, which pollute the waters of the Rhine, for example) has not been solved by traditional transport means.

In all the above mentioned cases, the transport is at the present time provided by highly effective means at a very low cost. Certainly, in order to draw up an over-all account of these transports, consideration should be made for auxiliary costs which are likely to considerably modify the social costs.

Nevertheless, a heavy commercial load should be sought for, hence, the specifications outline is as follows :

Average Weight	250 to 500 tons
Radius of Action	500 to 2000 km
Velocity	100 km/hr
Remark	Short landing over unprepared ground (possibly)

.The transport of quarry or mining products :

The railway is the best suited means of transporting these heavy products, and in all cases where the traffic warrants the construction of a railway infrastructure, there is no competition with the dirigible.

Accordingly, it is upon examination of these special cases that certain possibilities for use are brought to light.

-in the case of uranium mining from Arlit to Nigeria, the distance to the coast, the inadequacy of the surface transport system, the cost of its improvement and maintenance, the importance and cost of the truck fleet, which would be necessary, result in the consideration for evacuation by air transport, especially of the phosphated by-products of the mining.

-in the case of working mines or quarries in highly populated countries, the evacuation of products, at least toward the closest train station, results in an overloading of the road system to an extent which is incompatible with the financial means required for its improvement and with the environment.

In both cases, the commercial load should be as large as possible in order to ensure the reduction of costs:

Average Weight : 500 tons
Radius of Action : 100 to 2500 km.
Velocity : 100 km/hr
Note : Short or vertical landing

Supply of the Assembly Lines

/45

The example of air transport of spare parts between the Peugot Factories in Eastern Frand and Nigeria (Kaduna) brings to light the importance for a planned transport of large tonnages.

In 1975, 70 flights of mainly DC 8-55 F with commercial load of 35.7 tons have transported 2500 tons of spare parts (25 0 cars).

In 1976, 430 flights of mainly DC8-63-F with a commercial load of 43.7 tons have transported 10,052 tons of spare parts (15,000 cars).

The tonnages forecast for 1977 are 28,000 tons, for 1978 - 32,000 to 35,000 tons and for 1980, 50,000 tons are forecast.

To transport this traffic, the UTA is planning to buy a B 747-200-F with a commercial load of 122 tons.

The air transport over a distance of 4,600 km is accomplished in five hours, whereas road transports require seven hours in France (300 km) and five hours in Nigeria (260 km). The total time required for the transport, not including the time for transshipments, is, then, less than twenty hours; but the average transport time should be about 36 to 48 hours, including discontinuities in the load flow.

Parts for the assembly factory are stored about three days.

With respect to the tonnages to be transported, the daily tonnage to be transported in 1980, per working day, shall be about 200 tons.

Given these conditions, it is possible to use two or three dirigibles with a capacity of 500 tons and which are able to avoid the terminal road transports, both in Europe and in Africa, which would make the time required for the transport by dirigible comparable to the present system.

Other cases of assembly plants are planned for the future.

The dirigible specifications would be :

Average Weight : 500 tons
Radius of Action : 5000 km

Velocity : 150 to 200 km/hr
Note : Short landing

The Dirigible Used to Take the Place of Coastal Shipping /46

In several regions, the complete inventory of which was not presented within the framework of this study, the coastal shipping means of transport is entering a difficult phase from the financial point of view, and the lack of economic feasibility of some transports, either pure coastal shipping, or the treatment during the departure at main ports is likely to result in the elimination of services which are detrimental to the economy of the regions concerned.

In various cases, it is possible to consider a transport system based partially on dirigibles which are based either on the ships themselves, which would not involve difficult technical problems, or in the ports, or in the middle of a development region located on the sea-side, but not serviced by a port.

.Serving the Eastern Coast of Madagascar :

Along the Eastern coast of Madagascar, as well as in other regions poorly equipped with port facilities : Africa, Latin America, Indonesia and not having at their disposal a transport system parallel to the coast. The transport up to the point of destination is ensured by small tonnage boats, which have an easy access to coastal sites, even poorly equipped ones, and then after a second transshipment, the goods are conveyed by surface route to an inland point of destination.

This system is slow, risky, and not profitable to the operator (The Scandinavian East Africa Line has, for example, maintained two "stationary" ships to provide such terminal transports).

The use of average tonnage dirigibles could take the place of the system described above. This would provide savings from transport discontinuities, by allowing for connections to be made between the various poorly equipped coastal points and the main harbour, i.e. between the economic development zone and the cargo itself.

.Serving the North Sea :

The economic trend has caused several ship-owners in the North Sea, in the straits and in the Baltic Sea to eliminate their operations over the past few years on less busy routes and in secondary ports.

The dirigible cannot, of course, take the place of a sea-transport operation which operates at a loss in all cases. Perhaps it is possible to consider, however, a coordinated transport system where the busiest routes to the busiest ports are served by boat and the connections toward the coast or inland, in cases where infrastructures are inexistant or poorly equipped, would be served by average tonnage dirigibles.

.The Local Transport of Containers :

Containerization has become completely relocated to sea routes connecting to industrialized countries. Its world-wide expansion has been stopped, among others, by problems of financing as a result of the need to equip a rapidly increasing number of ports.

World-wide expansion has, then, slowed down in spite of the initiatives made, particularly in the Philippines, in the Caribbean, along the Western Coast of Africa, in South Africa, etc ... Furthermore, it may be observed that the "picking up" of containers in secondary ports tends to be carried out by specialized or unspecialized boats, but in all cases boats which are slower and smaller than the main-liner container-carriers.

The structure of these new lines is such that we tend to lose some of the advantages of containerization along some of the less busy routes.

In this situation, we have considered for departure points along the coast, where the traffic does not warrent a stop-over, and for inland departure points which are poorly served by surface transports, a loading system to be provided by the dirigible.

Given these various cases, the desirable characteristics of the dirigible would be :

Average Weight : 50 - 200 tons
Radius of Action : 500 - 1500 km
Velocity : 100km/hr
Note : Stationary flight (loading on ships) and vertical landing

.The Mass Transport of Containers Between Countries On Busy Routes

This traffic is provided by container-carrier ships, permitting very fast shipping times between equipped harbours and back-country routes served generally by a dense surface transport infrastructure.

The operation of a container-carrier dirigible may be considered between a limited number of centers where containers would be collected for long-distance flights. The problem of pre- and post-routing would still not be solved, as in the case for sea ports. The advantage of the dirigible versus the ship would be small.

The Airship Cargo Project (Max Rynish), on the other hand, would give the advantage of loading and unloading containers along an itinerary involving a large number of stop-overs.

The specifications to take into consideration are :

Average Weight : 5 tons (possibly more)
Radius of Action : 2000 km/hr for average distance connections with stop-over
Velocity : 150 km/hr (possibly more)

Note : Stationary flight if intermediary stop-overs are expected.

Short (or vertical) landing for point-to-point long distance connections.

The Transport of Vehicles : /49

The transport of new vehicles is rapidly expanding with departures from Europe, the United States, Japan, as well as between the Continental countries; this has justified the manufacturing of sea, road, railway and inland water vehicles.

In the case of long-distance exports, the use of a dirigible would make it possible to depart from the factory and would eliminate the breaks in load flows at the port.

This type of transport may be provided by dirigibles comparable to the ones considered for the transport of containers; hence, the characteristics are as follows :

Average Load : 500 tons (possibly more)

Radius of Action : 2000 km/hr (possibly more) for the delivery of small parts of vehicles needed in the sales centers.

6000 km/hr (possibly more) for long-distance connections.

Velocity : 150 km/hr

Note : Stationary flight if intermediary stop-overs are expected.

Short landing (or vertical landing) for long-distance connections.

The Transport of Petroleum Products /50

The transport of natural gas by dirigible has been suggested by the Institute of Battelle and by the University of Arkansas.

This suggestion is justified by the amount of investments required for the construction of conduits (long-distance gas pipe-lines which shall connect Alaska and the Eastern part of the United States during the 1980's , which shall cost at least 10 billion US $ for a distance of 4,500 miles. The oil pipe-line between the oil deposits of Alaska and the port of Valdez has cost 7.7 billion $ U.S. for a distance of 800 miles) for the construction of gas liquefaction plants for its transport by methane carriers and by the operating cost of the transport systems.

Comments will be made on these projects later on, and as interesting as they might be, they relate to a very specific use of the dirigible and not to a general use of the dirigible.

The characteristics, whether referring to towed balloons or to balloons partially filled with transported gas, are in fact very special cases.

1.3.1.6. Conclusions /51

The preceding analysis brings to light the interest for a heavy cargo dirigible :

.For the transport of indivisible masses (power plants, mining equipment, turn-key factories, off-shore equipment, boat components, components for highway structures) for which a commercial load of 250 to 500 tons & over seems necessary.

.For the transport of bulk products (mining and quarry products, farm products, forestry products, cereals, fruit, chemicals) for which the large commercial load reduces the cost of transport per unit of tonnage.

.For the transport of "light loads" and bulk loads, which a dirigible could group (pipe-lines, railway routes).

.For the transport of regular supplies (assembly plants).

The velocity generally mentioned in rough drafts is about 100 - 150 km/hr : this velocity is generally satisfactory.

The vertical landing and stationary flight (combined in some cases with a highly accurate landing) are desireable in most cases, except when the traffic streams are dense and regular or when the transport begins or ends at points equipped with runways (aeronautical and spatial components). The landing (short) must take place on unprepared ground.

The radius of action, on the other hand, is very variable, but may reach several thousands of kilometers in some cases of transatlantic or transeurafrican transports, for example.

Moreover, the analysis of requirements brings to light the interest for an average dirigible, the tonnage of which would be 50 - 100 tons (electrical construction, transport of containers, coastal trade, pipe-line transports) over distances of usually hundreds of kilometers.

Finally, the low tonnage dirigible (of about 15 to 25 tons) should find an outlet for transports combined with aerial work operations (forestry, construction of electrical lines, ship loading). Stationary flight and vertical landing are necessary.

1.3.2. Aerial Work By Dirigible /52

Aerial work is a very diversified field and is growing rapidly.

Four types of missions, and hence markets, may be mentioned and form the subject of the remarks presented below :

Handling Equipment

Handling may or may not be combined with a transport. It may or may not be combined with an industrial operation (building construction), or public works (excavation, construction of pylons, etc ...).

Handling by dirigible, then, takes the place of ground handling devices (cranes, travelling gantries), or maritime devices (floating cranes, sheers) or air devices (helicopters) : its interest is found in the size of the load it is capable of lifting (heavy and indivisible loads), in the capability of displacement without detriment to the handling device, in the independence it holds toward ground infrastructures and in the handling cost.

Work Platform With Crew

Missions for research (urban development, regional development, etc ...), supervision (pipe-lines, boundaries, maritime zones, ...), checking (animal migrations, road traffic), marking (icebergs), control, life-saving, etc ...

In this case, the platform receives the personnel, which perform the aerial work missions and the equipment necessary.

Scientific Platform Without Crew

All of the above mentioned missions may be ensured through scientific equipment on board (electrical radio means, measuring equipment, cameras, radio transmission devices, remote guiding devices, etc ...).

Special Missions

Considering its characteristics, the dirigible may be used as a vector in a wide variety of circumstances :

.The dirigible is used as a fixed anchoring point or mobile anchoring point (advertizing, lighting a large ground area, parachute or delta plane training, etc ...).

.The dirigible is used as a means of displacement to a given area, without the need to land or remain in the area (fire-fighting, farm or forestry works, advertizing, etc ...).

.The dirigible may be used as a means of acces to areas of difficult access where various operations may be carried out during stationary flight : (life-saving, health evacuation, transport of moving

flocks, advertizing, etc ...). /53

.Etc ...

The aerial work missions which are likely to be assigned to the dirigible are growing constantly and at a fast pace. This explains the diversity of desirable characteristics.

Nevertheless, besides the handling missions, which require commercial loads ranging up to several hundreds of tons, most missions justify a considerably lower commercial load, which in most cases doesn't exceed about ten tons.

1.3.2.1. Handling Missions

The interest for the dirigible as a handling device has been emphasized up to now in cases where the handling was intricately interrelated with a transport operation. The devices used for part or all of the handling have the common characteristic of having a capability for stationary flight and for vertical landing. Their radius of action and velocity are not determined by the "handling" mission, but by the "transport" mission which is connected to it.

Accordingly, we are taking up again below the missions which may be assigned to the dirigible as a function of the tonnages to handle:

Less than 5 Tons

The handling of such "packages" does not, in principle, present any problem in transport centers where discontinuities in the load flow take place. These centers are equipped with fixed or mobile equipment.

The problem of handling arises, then, on unequipped sites and where mobile handling devices cannot be sent in economical conditions. The problem arises also when handling devices are saturated in a port, for example. The freight to be unloaded may be found at a certain distance from the quay and the load may be deposited within the port zone, but not on the quays.

The case of working a forest in Europe has been treated previously; it involves a large market.

Most handlings performed by helicopter (building construction and finishing, etc ...) may be carried out by the dirigible.

In a more systematic manner, the 5 ton dirigible may be used /54
for mountain transports (with consideration given for atmospheric perturbations) for the transport of pylon components, pipe-line components, fixed handling devices (cranes), small public works devices, etc ...

The dirigible shall in all cases, or in some of them, compete with standard handling devices, but also with new techniques, such

as air cushion vehicles and semi-captive balloons guided by cables and hauled by winch(1). The ubiquity of the dirigible and its amphibious nature gives it, nevertheless, some advantages.

10 to 50 tons

The handling of these "packages" does not involve any problems in transport centers, which are in principle well-equipped, and the equipment of which is up-to-date. This is the case in most European ports, but in developing nations, the handling of such packages must be combined usually with a transport operation, if the infrastructure in the back-country is inexistent or inadequate.

The working of the forests in the Equator gives an outlet, considering the weight of logs.

The transports required for constructions located at sites with a difficult access (civil engineering construction sites, mines and quarries, construction of high-voltage lines, pipe-lines, etc ...) may be carried out by the dirigible, which in the case of sites with easy access would avoid damage to be brought to the site.

Furthermore, 50 tons makes it possible for industry to increase the amount of assemblies in the factory and hence to reduce labor costs at relocation sites.

The handling of containers must also be taken into consideration.

Construction site devices, prefabricated construction modulus, "light" high-way structures components, and bridge components, the systematic transport of concrete, for example, for the construction of hydro-electric dams, the transports required for oil drilling in generally unfriendly regions, must be considered.

100 to 500 tons

These tonnages are for heavy and indivisible loads which have already been examined, since the transport over a more or less long distance must be considered jointly with handling. Beyond a certain tonnage (250-300 tons and beyond certain dimensions (road and railway clearance), the transport of packages gives problems which increase with the characteristics of the package and the hesitation of government to authorize them on traditional networks.

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(1) A balloon of this type, designed by Lightspeed and Unsworth, should be used for unloading ships in the Port of Hodeidah (Yemen); it would have a volume of 46,000 m3, a lifting capacity of 10 tons and could unload 500 tons in one day. The displacement distance can reach 2000 m. This technique may also be used to work forests.

Some ports, such as Anvers, consider themselves as unfavored, since they have no access to exceptional convoys with the heavy and bulky loads. A traffic of packages with smaller dimensions tends to follow exceptional loads to another port. Also, the construction of a factory or of a power plant will depend on the transport of the heaviest or the most bulky component. Whether this transport is carried out by road or by rail can lead to quite disproportionate investments.

The transport of exceptional "packages" by dirigible will bring about a traffic of less bulky and lighter packages for this type of transport to the extent where the transport duration will be reduced and an appropriate tariff classification will be provided.

The handling systems described above, some of which may be combined with more or less long distance transports, lead to the following programs :

TYPE 1	Average Weight :	5 tons
	Radius of Action :	Several kilometers
	Velocity :	50 km/hr
	Note :	Stationary flight
TYPE 2	Average Weight :	10 - 50 tons
	Radius of Action :	Up to 200 km
	Velocity :	100 km/hr
	Note :	Stationary flight
TYPE 3	Average Weight :	100-150 t. (possibly more)
	Radius of Action :	2000 km (possibly more)
	Velocity :	100-150 km/hr
	Note :	Stationary flight

1.3.2.2. The Dirigible Platform With Crew /56

Missions of this type are multiple and we could not consider describing them all.

The main ones are as follows :

Research Missions :

Territorial development operations (marking of boundaries for roads, highways, railways, development of urban areas, development of maritime zones, Sight-seeing zones and Parks, etc ...) require a general perspective of crews from various disciplines (architects,

city planning engineers, surveyors, etc ...) whose activities are interrelated. Accordingly, it is advantageous for them to meet together at the site when certain equipment is required (photography, counting, detection, etc ...).

A commercial load of 4 - 5 tons should be appropriate for most of the missions of this type (10 to 20 participants, plus equipment). The dirigible is not required to have the ADAV characteristics, but must be able to remain in stationary flight.

The specifications would be then :

Average Load : 4 - 5 tons

Radius of Action : 500 km

Velocity : 50 - 100 km/hr

Note : Stationary flight - short landing (possibly vertical)

Surveillance Missions :

These missions are multiplying at the present time both on land and in the zone of territorial waters extending to 200 miles.

.City and countryside road traffic surveillance (Bridges and Roadways).

.Land boundary zones surveillance (police, guardsmen, customs officials).

.Control of territorial waters (police, guardsmen, marine experts, customs officials, anti-pollution control experts).

.Analysis of sea water quality and river water quality (maritime administration, anti-pollution control).

.Surveillance of air pollution

.Surveillance of linear infrastructures (High-Voltage lines, pipe-lines)

.Fire Surveillance (Civilian protection)

.Coast surveillance (Civilian protection) /57

.Surveillance of all large construction sites (dams, highways, sea port, etc ...) and large farms.

.Etc ...

These various missions are very heterogeneous, but if the crew and equipment constitute only small tonnages, the flight durations desired are very long and may extend to one full day and undoubtedly even more than 12 hours in order to avoid too frequent returns to the base.

Velocity is not the essential element, but it should reach, and even exceed 100 km/hr. Stationary flight is indispensable ; landing and take-off may be short. Weather resitance must be good, especially in maritime zones where flight capability in all weather conditions must be ensured.

The specifications should be then :

Average Weight : 5 tons

Radius of Action : 1000 - 2000 km

Velocity : 100 - 150 km/hr

Note : Stationary flight, short landing, all weather flying capability

Life-Saving Missions :

Even though Civilian Protection services are skeptical about the benefits of the dirigible (the helicopter seems easier to control, more flexible and efficient, especially for road traffic), it may be considered at least for the establishment of emergency operating blocks, which are likely to operate also during flight.

On a much larger scale, the use of the dirigible may be considered in the form of a flying hospital used world-wide when disasters affect an entire region, whether the disaster is sudden (earth-quake, tidal-wave flooding) or on-going (drought).

The dirigible may be used for the implementation of the ORSEC, POLLMAR, etc ... plans.

Two types of specifications may be considered ; they are naturally quite different : /58

TYPE A	Average Load :	10 tons
	Radius of Action :	Several hundreds of kilometers
	Velocity :	150 km/hr
	Note :	Vertical Landing
TYPE B	Average Load :	250-500 tons
	Radius of Action :	2000 - 5000 km
	Velocity :	100-150 km/hr
	Note :	Vertical landing ; possibility of stationary flight, dirigible acces achieved by hoist

Research, Detection, Marking Missions :

These missions, like the surveillance missions, are highly diversified and develop very fast. The dirigible appears as a supplement to satellites, airplanes and ground facilities. The missions require, in general, the air transport of equipment, which does not have to be miniaturized, as in the case for the airplane.

THE B R G M gives two examples of these kinds of possible use :

"The dirigible could be used, in episodes, for a specific mining exploration technique : low-altitude airborne geophysics. The capability of slow-motion and stationary flight, would make it possible for light dirigibles (load of less than one ton) to execute low-altitude airborne radiometry, for example, in rough areas which airplanes cannot reach for safety reasons. It would be necessary for the operating costs, in these cases, to be lower than for the helicopter. "

"With respect to airborne geophysics, we may always provide the use of devices with 5 to 10 tons of useful load, which carry out multiparameter studies (radiometry, gravimetric investigation, etc ... with a pre-processing of data on board) in a systematic manner, resulting in a real flying geophysical laboratory fitted under the dirigible."

According to CNEXO, a large number of missions carried out in maritime zones (investigation of schools of fish, exploration of the bottom of the sea, water temperature analysis, short-term meteorological forecasts, sea streams analysis) may be considered.

Depending on the amount of equipment to be transported, the commercial load of the dirigible should vary between several tons and 10 tons; /59

For ocean missions - and some experts at CNEXO think that most missions assigned to oceanographic boats could be assigned to the dirigible - the desired flight duration may be several days, but the aircraft velocity permits the exploration sites to be reached very rapidly.

On the other hand, in the case of land exploration, the time may not be longer than one day. Stationary flight is then indispensable.

Accordingly, the specifications are :

Average Load : 10 tons

Velocity : 100-150 km/hr

Duration : 15 hrs (land version)
8 days (sea version)

Note : Stationary flight, short or vertical landing

A very special long-distance marking mission has been considered with the CNEXO : it is an iceberg marking mission in the Antarctic regions : the dirigible could therefore also be used for the transport of equipment required for insulation and for towing the iceberg to Saudia Arabia.

1.2.2.3. The Scientific Platform Dirigible Without Crew /60

The presence of crew members on board the dirigible is not always necessary. This is the case of missions for which the objective is to record data or transmit data or orders, etc ...

Research was carried out with devices without crew members in two French examples, called the Pégase Project and the Dinosaure Project which are briefly described below :

The Pégase Project (Geophysical and Stationary Astronomical Research Platform) was initially designed as an observatory on board, and then studied as a telecommunications relay.

This latter concept should lead to a system of devices composed of 11 to 20 platforms stationed above a country of the size of France, with each dirigible stationed, by dynamic anchoring, at about 20,000 in altitude and "covering" a circle of 200 to 300 km in diameter.

The vehicle should be capable of sustaining a useful load of 2 to 5 tons. Account taken of the flight duration, of about one year, the vehicle was designed for a mass of 175 tons and a volume of three million m3 (300 m in diameter and 70 m in height).

The Dinosaure Project involves an atmospheric exploration device without crew, with remote control and telemeasuring so that all piloting and observation operations are automatic.

The dirigible with a total mass of 1,425 kg may be used at an altitude between 1,500 and 3,00 m with an autonomy of 10 hours.

Missions which are likely to be assigned to scientific platforms without crew are the following :

.Point to point telecommunications upon request by using several stationary dirigibles as relays.

.Television relays (22 transmitters located at twenty kilometers in altitude would be adequate to cover France).

.Observation and detection of land resources.

.Meteorological applications (detection of cloud layers, short-term forecasts, etc ...).

.Scientific applications : astronomy and aeronomy.

.Ground photography.

.Assistance to sea navigation (telecommunication relay).

Some scientific organizations or research organizations have /61
been interested in the use of geostationary balloons (DATAR, DGRST, ONERA, METEO, CEA, ORTF, DNA, DIRCAM, CNET, CNES) having a useful load of 0.5 to 5 tons and a flight altitude of 20/30 km for general studies and an altitude of 1,000 to 5,000 m for specific studies.

The use of non stationary balloons at several hundreds or thousands of meters in altitude has been considered by various organizations, including Météo (observation of cloudy layers), CNEXO (observation of low atmoshperic layers and the middle of the sea), Radio Diffusion (retransmission of reports), etc ...

1.3.2.4. Various Missions

We have grouped above, for the sake of information, a few missions which are difficult to classify, but the interest of which may be quite considerable in some economic sectors, such as agriculture.

1.3.2.4.1. Agriculture

The dirigible may be used to perform above a given area certain operations which do not require landings ; it may then substitute for air equipment (airplane, helicopter), or ground equipment.

We have retaken below a few farming and forestry examples, etc .. mentioned in the Soviet studies and have made comments on them as needed :

.Forest conservation operations (aerial seeding, pollination of cedar and pine trees, spreading of fertilizers).

"At the present time, forest improvement works cover a surface of 18 to 20 million hectares per year. As a result, it may be expected that the use of dirigibles will make it possible to save approximately 55 million roubles per year (1). To accomplish this, a park of 20 5-ton dirigibles should be provided."

.Fire prevention and fire-fighting : the missions may range from /62
surveillance to the transport of defense means to areas which are difficult to reach for direct fire-fighting by water-spraying.

If fire-house surveillance can be carried out by using the dirigible instead of by airplanes (agreements have been made in Corsica, for example, between the Civilian Protection Service and French Air Clubs), the Civilian Protection Service is still skeptical about using the dirigible for direct fire-fighting in forests.

This skepticism is based on the following reasons :

-How shall the dirigible react close to the seat of fires which it shall be expected to fight at close range (protection from flames, behavior of flight at the moment where water is discharged, engine

(1) The estimates are about 10 years old.

in hot zone : the Canadair approaches to 30 m, but the engine "dies", if the dirigible remains too high, efficiency of the fire-fighting is reduced).

-Behavior of the dirigible in the case of frost (there is frost in 1 % of the cases of missions undertaken by the Protection Civile, for which airplanes leave on long-distance missions).

-How shall the problems of water supply be solved? Bailing out? Pumping? Re-supply through an airport? Is the supply rate reached by Canadair (5tons of water in 14 seconds) possible to exceed?

-How fast shall the dirigible act? The fleet placed at the disposal of Germany in 1976 was on location in 6 hours (Marseille-Hambourg) ; In Corsica, the airplane loaded with water was generally at the site in one fourth of an hour. All of Corsica is covered within one half hour. The maximum in the Provence is 40 to 50 minutes.

-Since the combination wind-fire is frequent, what shall be the behavior of the dirigible in the case of a violent wind ?

.Protection against farm damage and the implementation of various works :

"In agriculture, the dirigible may be used on a large scale for various works, such the protection by chemical processes applied to weeds, predators and crop diseases, the transport of crops between distant fields and silos and the transport of heavy farm machinery to regions where the road system is inadequate.

The table below gives some characteristics of equipment constructed by Massey-Furgeson, which may be considered as typical, and the transport of which involves problems in some circumstances: /63

TYPE	WEIGHT	WIDTH HT	LENGTH HT	HEIGHT HT
Tractor				
MF 1805	7,900 kg	2.51 m	5.69 m	3.33 m
MF 1135	5,500 kg	2.39 m	4.50 m	2.87 m
MF 595	4,500 kg	2.04 m		
Harvesters				
MF 760	9,000 kg	4.14 m	6.92 m	3.60 m
MF 620	7,630 kg	2.97 m	6.30 m	3.28 m
MF 520	6,350 kg	2.77 m		

"Dirigibles may be used to prepare the ground for snow, to transport cattle to distant pastures, and from pastures to slaughter houses ; during periods of drought, dirigible could be employed to irrigate the fields. (K.E. Tsiolkovsky).

"According to the results from experiments carried out by the Institut National de Recherche Scientifique sur l'agronomie (National Agronomics Scientific Research Institute), dirigibles may be used at the beginning of Spring and Autumn when herb seeds and perennials are sown on natural fattening prairies ; they may also be used to ensure the fertilization of gardens and vineyards.

Calculations made by the bureau d'étude E. Tsiolkovsky(E. Tsiolkovsky Research Institute) in connection with other scientific and farm research institutes, show that by using dirigibles for some farm activities, work productivity shall be substantially increased, the length of seasonal operations shall be considerably reduced and the cost-price shall be greatly reduced.

Accordingly, upon examination of the figures provided by the Institut de Recherche National pour la Défense des Plantes (National Research Institute for the Protection of Plants), it seems that a 50 ton dirigible is capable, at a velocity of 70 km/hr, of treating a surface area of 3,500 hectares per hour with chemicals. It is estimated that the savings made versus the cost for the same work performed by airplane over an area of 46 900 hecatres is as high as 650 000 roubles.

According to the same Insitute, in the same case of a chemical treatment of crops from a dirigible, the savings shall reach about 6.7 million roubles. Accordingly, the total savings incurred through the use of the dirigible for treating crops with chemicals shall amount to 12.3 million roubles.

.Transport and Spreading of Inorganic Fertilizers /64

This question has also been studied in the Soviet Union, where an attempt was made to determine, on a general level, the benefit of the general use of the dirigible for the transport of inorganic fertilizers.

"Currently, the transport of inorganic fertilizers is ensured mainly by railway and by trucks. In order to convey from the factory to the fields, the amount of inorganic fertilizers defined by the Plan of 1970, a multitude of freight cars and hundreds of thousands of trucks shall be required. Ten times as much additional equipment shall be necessary for spreading the fertilizers over the fields.

If dirigibles are used to carry out the operations, it shall be possible to simplify and accelerate the transport and spreading of the fertilizers and to reduce the cost-price.

Endowed with a large loading capacity (100 tons and more), a relatively high speed and capability for vertical landing and take-off, the dirigible can pick up a load of containers weighing 50 to 100 tons of fertilizers and transport them rapidly to their point of application. In these enormous containers, which look like transportable and perfectly equipped warehouses, the fertilizers may be preserved for an undetermined period of time in the fields, without being subjected to the damaging effect of rainfall.

It is therefore no longer necessary to build warehouses in the factories, train stations and on farms. It is no longer necessary to organize the storage of switching yards during the trip : no longer necessary to make numerous round-trips between warehouses. Accordingly, a considerable number of means, both financial and in equipment, shall be liberated.

In 1963, 1 700 000 tons of fertilizers were lost during various transports. We may hope that the adoption of this new method shall considerably reduce the wastes. Furthermore, it should be taken into account the profit which will result for the government due to the fact that a large number of vehicles will be freed (about 14 000 two-axle freight cars and more than 17 million truck trips), as well as a large number of warehouses, handling equipment and labor.

The use of dirigibles in agricultrue will contribute, without any doubt, to larger crops and more stable crops and will have an important effect on the cost-price. Specialists from various organizations and working jointly have provided an average figure for the savings accomplished, which is the amount of several hundreds of millions of roubles per year."

The above quotations are certainly opt mistic, they relate to a period in time where the dirigible has not yet become of general use, but research relating to its use has become extensive.

The optimism of the Soviet technicians does not seem to be /65
shared by the French technicians ; this is because - besides the fact that the problem has been studied very little - the use of the dirigible has been considered for the treatment of vast stretches of a mono-crop system in the Soviet Union, and the operating conditions over such large regions are quite different than in Western Europe.

In fact, the conclusions of a study conducted by the Centre National d'Etude et d'Expérimentation de Machinisme Agricole (National Center for Research and Experiments of Farm Machinery), in collaboration with l'Ecole des Arts et Métiers (Arts and Crafts College) were difficult to make and a firm stand was not taken.

Nevertheless, it appears in most cases where operations can be carried out by airplanes or even special low-speed airplanes, the airplane is a better choice than the dirigible. In other cases, such as for the pesticide treatments, it is better to perfect helicopters without pilot, rather than dirigibles."

1.3.2.4.2. Other Examples of Missions

Advertizing :

The dirigible is currently used as an advertizing support. This activity is likely to develop in the proximity of urban areas or areas with strong tourist activity. The dirigible shall be a light dirigible (less than 5 tons). Its velocity shall be less than 50 km/hr, but it shall be able to stay airborne for ten hours. A short landing is adequate.

Jumping Platform :

For the development of sports, such as parachuting, the launching of deltaplanes, the same characteristics will be selected as in the previous case, except for flight duration, which can be much shorter.

1.3.2.4.3. Conclusions

The preceding analysis makes it possible to distinguish three main applications for the dirigible.

The dirigible used as a handling device appears quite interesting, due to its wide variety of applications, for an extremely wide range of commerical loads : 500 t., 100 t. - 50 t. -10 t. and 5 t., and a wide rango of radius of action, since the handling mission is generally combined with a transport mission.

In general, the vertical landing is required ; in all cases the stationary flight is imperative and it must sometimes be accompanied by a highly accurate landing position.

Missions of surveillance, detection, research, etc ... are multiple and expand rapidly along with the development of the zones te they operate in (zones of 200 miles - improvement of developing zones- operation of polar zones). /66

This sector of activity is essential. If there are very numerous variants, the main function of the missions must be capable of being carried out by the dirigibles having a small commerical load : 5 to 10 tons with a maximum of 20-25 tons in some special cases seems to be adequate.

The speed of cruises must be capable of reaching 100 km, but the stationary flight is indispensable. Short landing is undoubtedly adequate in most cases.

Agricultural and forestry and similar missions (fishery), may be also ensured by dirigibles with small capacities (5 to 20 tons) in most cases, to the extent where the work of the mission is not combined with a transport mission.

The speed may (or should) be slow, less than 50 km/hr. The stationary flight and vertical landing are desirable, but are not indispensable.

Besides these three groups of mission, exceptional cases have been detected such as :

.The geostationary dirigible, the commercial load of which small (5 to 10 tons), but the duration of the missions and the fl c altitudes have very special characteristics.

.The flying hospital, which must have a combination of the characteristics of a very high commercial load, high speed, extended stationary flight, etc ...

.The hauling dirigible, which may be considered to tow balloons filled with gas or floating landing gear on rivers with no transport structures.

Etc ...

It is obvious that the diversity and constraints of these latter missions do not give them a market value in a reasonable period of time, due particularly to the competition they must confront.

1.3.3. Passenger Transport /67

Historically, the objective of the dirigible was its use as a means for transporting passengers, as in the case of the Zeppelins.

With the pressing need for a means to transport cargo, and the interest in the dirigible for various aerial operations, its use for passenger transport became secondary.

The various possibilities offered to various fields of passenger transport, however, should not be overlooked.

1.3.3.1. The transport of small groups of people, when sites are difficult to reach or are inaccessible by surface routes, in the case of urban or airport connections, etc ...

In such conditions, the transport is normally provided by helicopter (which is expensive), by all-purpose vehicles (which is expensive or slow), or on foot (which is slow).

The transport of small groups of passengers may be carried out in sensitive areas when the dirigible is better than other modes of transport:

Maritime Zones :

The transport to marine platforms, light houses, construction sites near the coast (construction of harbor facilities, inland transport to vast port zones, etc ...), the transport of passengers to meet airline connections in the case of Archipelagos where aeronautical ground equipment does not exist.

Mountainous Zones :

High-rise construction (refugees, high-voltage lines, hertzian or television relays, forestry, farming or sheep-herding), the transport of skiers and tourists.

Swamp Zones

Transports required for oil exploration and drilling, forestry operations ; transports required for the construction of surface infrastructures ; economical, administrative displacements toward

centers where the construction of permanent infrastructures is impossible.

Disaster Areas

Most civilian protection missions require emergency displacements. In many cases, there are no infrastructures to support the transport device.

Highly Urbanized and Congested Zones /68

The problem of urban connections in large cities along the sea or in urban complexes where there are numerous discontinuities in the flow of transport or considerable detours by surface routes have not always been solved by air, land or water transport routes, in spite of the extensive research conducted (traditional boats, air gliders, sea-planes, helicopters, short landing airplane, land routes).

In various cases, the operation listed above are supplementary to aerial work operations and the groups to be transported may include 15 to 20 people.

In the case of intra-urban transports, the desired capacities should reach 40 to 50 passengers.

In all cases, the transport cost should be considerably lower than for the helicopter and the device should be easy to control.

An average velocity of 50-70 km/hr is acceptable as long as the superiority of the dirigible lies in its capacity to pass over ground obstacles.

The specifications are, then :

Average Load : 5 to 10 tons

Radius of Action : 100 - 200 km

Velocity : 50 - 100 km/hr

Note : Vertical landing

1.3.3.2. Mass Passenger Transports

Air and sea transports ensure most of these conveyances as long as a sea zone or a zone lacking surface trnasport means (discontinuity in the flow of transport) must be crossed.

The dirigible may find an application as long as :

.The cost-prices are lower than for the airplane or for a combination of several modes.

.The velocity shall remain relatively high (above 100 km/hr, so that the Mediterranean, for example, can be crossed in one night).

.The supporting infrastructure will be small and near the points of destination so that transshipments and discontinuities in the flow of the load may be avoided. /69

.It will be possible to provide a continuous use, or quasi-continuous use of the dirigible by transferring it from one spot on the globe to another, from one season to another.

The capacity of the device may be high, ranging from 500 to 1 000 passengers to meet such requirements as :

.The transport of migrations (Maghreb - Europe - Sub Continent (Indian) - Middle East).

.Tourist transportation in the Mediterranean or in the Caribbean for example; a special case may be considered : to help fill vacation villages. In this case, the dirigible would provide a door-to-door service, which would make it possible, at least in the countries of destination, to avoid transport change-overs.

.Some emergency transports, for example, to evacuate from diaster areas (the user could be a United Nations agency).

Average load : 50 to 100 tons

Radius of Action : 2000 km

Velocity : 100 to 150 km/hr

Note : Short landing

1.3.3.3. Car-Carrier-Transports

On some routes, such as connections between England and the Continent, Scandivavia - Europe, Japan, Australia, Tasmania, North and South New Zealand, Rio de la Plata, etc ... there is strong competition between competing means of transport (air, car-ferry, air glider, rail and road in the case of the construction of continuous infrastructure : the quick success of air gliders on the English Channel demonstrates that a balance may be disrupted as soon as a new mode is introduced.

The advantage of a dirigible with a large capacity, as long as the transport cost is comparable to the cost of maritime transport, would be to choose an inland unloading point in order to avoid congested zones of the road network.

Accordingly, the specifications are :

Average Load : 50 to 100 tons

Radius of Action 1000 to 200 km Velocity : 100 to 150 km/hr

Note : Short landing

1.3.3.4. Cruises /70

This is a field where the use of the dirigible may be given special consideration.

Two main cases may be considered :

.Use of dirigibles with small capacity (50 to 100 seats, or the equivalent of two cars) to make one-day tours, returning to the point of departure : tour of the castles of the Loire, tour of Brittany, tour of Corsica, Costa Brava, Greek Archipelagos or Turkish coast, etc ... The equipment of such a device would be minimum, since only seats with a panoramic view would be needed. It should be capable of landing on a small area to allow for ground tours.

.The use of cruise dirigibles with hotel accomodations for 300 to 500 people, at least, (bed-rooms, meeting rooms, retaurant, activities room, etc ...).

Accordingly, the specifications are :

TYPE A	Average Load :	50 tons
	Radius of Action :	1000 - 1500 km
	Velocity :	100 to 150 km/hr
	Note :	Vertical landing and stationary flight
TYPE B	Average Load :	250 tons (possibly more)
	Radius of Action	1000-3000 km (possibly more)
	Velocity :	100 to 150 km/hr
	Note :	Short landing (possibly vertical) and stationary flight

1.3.4. Military Missions /71

Military missions do not directly belong in the framework of this study. They are nevertheless numerous, but have not been extensively researched.

Some of these missions, however, are quite comparable to civlian transports : their interest lies in the fact that the civilian and military markets put together result in a substantial over-all market.

Military missions take place in zones lacking infrastructures, whether voluntary or not, which by definition are sensitive areas comparable to mountainous, swampy, water zones, etc ... Furthermore, a greater part of military missions take place in sea zones.

Missions which are likely to be assigned to the dirigible by the three branches of the service are :

.missions for the transport of passengers
.missions for the transport of freight
.missions for aerial work

.missions for specifically military operations

It has been mainly the American and Soviet armies where use of the dirigible has been taken into consideration. The French Army doesn't seem to have taken interest in the problem.

Results of Soviet research are not available, but given the geographical structure of the country, it may be deduced that missions in the Siberian zone (Chinese boundaries and the Great Siberian North) are of predominant interest because of the limited permanent infrastructures or surface transport system, because of circumstances, or for geographical, topographical and climatic reasons (Greath North), and due to circumstances which are more or less voluntary (Chinese border).

1.3.4.1. Missions for the Transport of Troops or Cargo Constituting A First Application of the Dirigible

Passenger Transport

This transport may concern either work units (construction of an air base, of a highway structure), or combat units in the back-country or near combat zones. The transports may be over short distances, or over long distances : transports to the arctic regions are an example of long distance transports (construction of airports in North Canada).

The entire range of commercial loads and radius of action may be considered when the dirigible is armed for defense and is used in all weather conditions and may approach any type of terrain (stationary flight). /72

Cargo Transport

This transport may also relate to standard freight, whether containerized or not, in various quantities and over various distances (basic provisions, transport to a construction site) or military equipment (transport or combat vehicles). The transports shall be made in "sensitive" zones or in zones which are likely to become "sensitive".

Assigning dirigibles to military-type operations results in characteristics which make them different from the ones used for commercial purposes, on various levels, even if the general design is similar.

The dirigible must be as independent as possible from ground equipment and must be capable of loading or unloading, embarkation or debarkation, by a hoist system transporting blades or containers, or by helicopters or STOL airplanes on board. This may imply, for reasons of safety or efficiency, the installation of a mooring system (mast) fitted to the ground, by crews and equipment transported by the dirigible itself or by ship (experiment of the American Marines).

The dirigible can be repaired during flight : the vulnerability of the dirigible has been frequently pointed out by its opponents. As a matter of fact, there is no evidence that it is more vulnerable than a ship, for example. Moreover, the total destruction of a dirigible (the gas is not inflammable and is distributed into its distinct compartments), would require a large number of quite large missiles. In any case, damage caused by an ennemy projectile can be repaired during flight.

Finally, the dirigible must be armed for counter-attack or for offensive attack, since the device was not designed for offensive combat.

With this, several types of missions leading to various possible specifications may be considered.

Average and Long Distance Military Transport

Basic supplies for distant installations (Arctic), installation of military equipment in distant zones (Africa), large military works (air or naval base, road infrastructures, or other).

This is for heavy transports, likely to be planned, carried out outside of combat zone. This type of mission is similar to some civilian transport missions (civil engineering works).

The freight to be transported may be composed of various goods, containerized products or equipment exceeding clearance (heavy and indivisible masses). /73

Such transports are currently carried out by all modes : ship, airplane, road or inland water routes, etc ...

Specifications outline :

Average Load 50 to 500 tons

Radius of Action : 500 to 3000 km

Velocity : Above 100 km/hr

Note : ADAV (possibly ADAC and stationary flight)
Dirigible armed or not

Short Distance Transports

Are likely to be carried out near combat zones : re-supply of troops, operations of debarkation, unloading of ships, transfer from one ship to another, installation and transfer of military equipment, evacuation, country hospital.

For average tonnage transports carried out in possibly difficult conditions and from ships or unprepared ground. The products to be conveyed are very diversified (containers, various goods, vehicles, military devices, etc ...).

Such transports are currently carried out by road vehicles, amphibious devices, helicopters, barges, etc ...

Specifications outline :

Average Load : 25 to 100 tons

Radius of Action : 50 km

Velocity : 50 - 100 km/hr

Note : ADAV and stationary flight
Unarmed dirigible, protection ensured by air escort

Some variants of the transport missions presented above are considered by the Army, Marines and American Air Force : /74

.The re-supply of distnat bases would require a radius of action of about 4,000 to 20,000 N.M.

.Some logistics transports would require a commercial load moderatly exceeding 500 tons or the capability of embarking packages which exceed clearance.

Generally speaking, however, the missions to be assigned to the dirigible are comparable to civilian transport missions.

1.3.4.2. Aerial Work Missions are numerous and highly diversified

They are for the surveillance of more or less extensive areas, especially sea zones.

The dirigible not limited by tonnage allows for :

.Long term missions (high sea patrols, surveillance of arctic regions, escort of sea convoys, meteorological observations, space observations, detection of missiles, control in vast sea zones).

.The availability of a platform likely to be equipped with bulky and heavy equipment (laboratory).

.The availability of a platform likely to support a crew and laboratory technicians in large numbers.

.Variable velocities, but is capable of slow velocities (stationary flight).

Missions which could be carried out by dirigible are done so at the present time by airplane, boat, satellite, or by ground equipment.

Rough Outline of Specifications :

Average Load : 20 - 50 tons

Radius of Action : 1000 - 10 000 km

Velocity : 10 - 100 km/hr

Note : ADAC or ADAV and stationary flight
Armed dirigible

Le Centre de Prospective et d'Evaluations du Ministère des Armées /75
(Army Research and Analysis Center) has not studied systematically the possible applications of the dirigible, since the problem has not been formally presented by any of the three branches of the service.

Surveillance of the coastal zone of 200 miles shall present difficult problems to solve in current conditions and credit availability.

This surveillance requires three types of missions :

.Data collection by satellite, by airplane, etc ...

.Identification which requires arrival near the marked objective in reasonably fast time limit, since the speed of the air device is always faster than for the sea device.

.Action on target, requiring certain weaponry.

Due to budget restrictions, France implements diverse means to ensure the three types of missions : at the present time, the airplane is selected to meet the needs.

Since autonomy, however, is given priority over speed, the dirigible could compete with the airplane because of its great autonomy plus ease of control (identification mission requiring motion around the objective) and a continuity in use regardless of meteorological conditions, the capability of minimum defensive weaponry and operating costs - account taken of aircraft kept in reserve to meet any system failure - are comparable to those incurred by the airplane.

Moreover, the C.P.E. insists on the vulnerability of the dirigible, but is aware that it is undoubtedly not more than for a ship.

Besides surveillance missions proper, various other capabilities have been considered, particularly by the American Army:

.Control of military operations, particularly airborne operations (it must be ackowleuged, however, that the dirigible is a particularly tempting target).

.Meteorological measuring station, this mission was made possible but its wide radius of action, the capability for stationary flight

and staying in the air for a very long period : this mission may be assigned to satellites or to meteorological ships.

.Convoy escort : the wide radius of action and the capability of staying in the air for a long period of time, makes this mission possible, especially since the visual scope of the dirigible is greater than for the ship. In the case, however, where the dirigible would be armed with air-sea missiles and air-air missiles, its defensive role is less effective than that of the ship. /76

Finally, it should be pointed out that the American Army would consider the dirigible without crew for some missions (surveillance missions, re-supply missions to isolated points).

1.3.4.3. Purely_Military_Missions

are diversified, even heterogeneous ; they require special performances and characteristics of the dirigible, which are not in the framework of this study.

We shall list, for example :

.Army operations combined with surveillance missions and detection missions at high-sea (the dirigible may be armed and have air-sea missiles and air-air missiles : it would be a mobile launcher of tactical missiles and strategical missiles).

.Active surveillance of airborne or amphibious military operations, with the assistance of Army support.

.The installation and lifting or destruction of sea mines (1).

.Parachuting platform

.Control platform

.Equipment to assist sea and air navigation

.Automatic surveillance missions, by device without crew

Account take of the special conditions for the use of military equipment, besides the characteristics proper of the mission to be accomplished, the dirigible for military use, in all cases :

.must be likely to use unprepared ground and to have ADAV or ADAC characteristics.

---

(1) This use appears to be the only one which is likely to be selected by the Centre de Prospective et d'Evaluations of the Ministère des Armées (Army Research and Evaluation Institute) due to the increasingly greater perfectioning of mine technology and the problems arising from the construction of mine dredger operators.

.must be capable of navigation in all weather conditions.

.must have a good system of protection against ground and airborne armies.

.must be as silent as possible.

2. DETAILED STUDY OF A FEW SPECIFIC MISSIONS /77

The general table presented in Chapter 1 makes it possible to determine the main characteristics of the dirigibles, based on the missions to be accomplished.

It is not possible to present an extensive study of each of these markets within the framework of this study. Accordingly, we have chosen to examine in detail some of the characteristic missions which have loop-holes for equipments of decreasing tonnage.

The preceding analysis results in the consideration of four main categories of dirigibles :

The heavy 250 to 500 ton dirigible, and possibly heavier, which is capable of providing the transport of heavy and indivisible loads in industrialized countries as well as the transport of bulk products, of containers, of various goods over long distance or average distance routes.

The average 50 to 100 ton dirigible, and possibly more, to connect with the level of 250 of the preceding category, is capable of providing over average distances the transport of various goods, of handling operations combined with average transports, of the transport of bulk products combined with public works construction sites, of the transport of containers, etc ...

The small 10 to 20 ton dirigible, and possibly heavier, in order to correspond to the 50 level of the preceding category, is capable of providing forestry operations in the tropical zones, handling operations with or without transport operations, surveillance missions, detection missions, etc ... and possibly passenger transport.

The 2.5 to 5 ton minidirigible, is capable of undertaking forestry operations in temperate zones, the handling of small loads over rough terrain, various aerial work operations (surveillance, detection, photography, advertizing and possibly the transport of passengers.

The missions studied are grouped according to the types of equipment above.

2.1. THE HEAVY DIRIGIBLE OF 250 - 500 TONS

2.1.1. The Transport and Installation of Heavy and Indivisible Loads

This section was studied during research of the GIE Dirigible (I), which concluded that the market for the trnasport of heavy and indivisible loads, based on the number of yearly missions and in the period 1980-1985, was the following :

Groups of Expenses	Potential French Market	Potential European Market (Excl. France)	Over-all Potential Market
35 / 50 T	1400	4200	5600
50 / 75 T	330	1000	1330
75 /100 T	450 / 750 *	1350 / 2260 *	1800 / 3000 *
100 /200 T	260	780	1040
200 /300 T	70	210	280
300 /500 T	150	450	600
500 /700 T	7 / 50 *	20 / 150 *	27 / 200 *

*Possible values if it is technically possible to satisfy the estimated oil requirements, taking into account the performances of the device and the meterological conditions it shall be capable of enduring.

(I) The participants were :

AERAZUR	CNES	L'AIR LIQUIDE	SFENA
AEROSPATIALE	EDF	ONERA	SOFRESID
CEA	IFP	RATIEP FOREST	TRANSCONSULT
			ZODIAC

Translated in potential fleets, this traffic corresponded to the following fleets, given the assumption that a transport mission, within Europe, and with return to the base requiring three days for loads exceeding 100 tons and two days for loads less than 100 tons, and that given favorable meteorological conditions, the dirigible could be used 200 days per year.

Type	Expense Classification	Potential Fleet			
		For French Market		For European Market	
		For 100 missions	For 66 missions	For 100 missions	For 66 missions
I	35/100 T	22	(1)	87	(1)
II	100/300 T	3	5	13	20
III	300/500 T	2	3	6	9
IV	500/700 T	1	1	1/2 (2)	1/3 (2)

(1) The mission for small loads is planned to last two days.

(2) Provided that the performances of the device, the needs of the oil tankers may be satisfied.

These estimates made in 1974-1975, are not optimistic, because the transport of heavy and bulky loads causes more and more big problems, both within the country where equipment is manufactured (inspite of diverse itineraries planned and developed for this use), and within the various geographical sectors of the world where they shall be delivered, then used.

These problems may be roughly classified into two main groups : /80
Problems with direct effects arising from the transport itself, namely :

.Difficult and costly study of the transport to be carried out (examinations, selection and detailed exploration of the possible itineraries).

.The availability of the various means of transport required (trailers, crawlers, barges, ships, hoisting and handling equipment, etc ...).

.Receiving official authorizations (case by case) with possibly

-creation of road sections or connection of railway routes,
-temporary or permanent reinforcement of existing routes, highway structures,
-displacements, temporary or not, or destruction of various obstacles, etc ...

.The costs and time limits for carrying out these transports may often be seriously increased by the need to use successivly different means of transport with a large number load flow discontinuities. Furthermore, the distance covered between departure and arrival may reach 5 to 10 times the actual distance between these two points.

The problems with indirect or induced effects arise mainly from technical and technological problems of the manufacturers and are problems which can have a definite economic incidence. In fact, the limit of the weights and volumes, due to transport difficulties, may result in :

.A power limit

.A costly study for the "relative miniaturization" of equipment.

.The adoption of a technology permitting the components to be broken down into parts and then reconstructed on the building site. This method implies additional manufacturing works, treatments, checks, etc ... and with additional human, equipment and financial input.

Since the number of transport operations of heavy and bulky loads tends to increase, as is shown in the survey made in the French ports and at Anvers.

The number of packages of more than 50 tons in transit in the French ports rose from 13 (804 tons) in 1974 to 36 (7,165 tons) in 1976 at Bordeaux - for the same period the amount rose from 100 (7,000 tons) to 180 (13,700 tons) at Havre - from 77 (11,800 tons) to 147 (21,600 tons) at Rouen, whereas the tonnage of this type of shipment climbed from 9,600 to 11,900 tons at Marseille. /81

This increase, which is characteristic in other large ports, and particularly at Anvers, results in a systematic policy of installing heavy handling equipment.

The free port of Havre has two floating derricks of 90 - 200 tons and plans to put in a 650 ton land derrick in the near future, in order to meet the requiremnts of heavy package traffic and the flow of investment goods (processing, boiler).

Examples	Load Mass (t)	Distance Factory to Site	For the Mission: Total Distance by Air (Diribible)	For the Mission: Distance total by Surface Rts	No. of Handlings by Surface Rte	Global Cost Estimated Surface Rt (a) in M.F.	Estimated Global Cost by air (dirig) in M.F. 3000 h an (b)	Estimated Global Cost by air (dirig) in M.F. 2000 h an (c)	Cost Ratio a/b	Cost Ratio a/c
1	280	430 km	750 km	4 700 km	5	2,00	0,59	0,65	3,39	3,08
2	364	385 km	690 km	435 km	2	0,60	0,56	0,62	1,07	0,97
3	480	426 km	570 km	4 445 km	5 x 3	2,50	0,52	0,56	4,81	4,46
4	420	492 km	780 km	4 195 km	2	1,80	0,60	0,67	3,00	2,69
5	364	435 km	600 km	4 635 km	3	1,90	0,53	0,58	3,58	3,28
6	384	255 km	540 km	365 km	3	0,60	0,50	0,55	1,20	1,09
7	420	423 km	630 km	825 km	3	2,10	0,54	0,59	3,89	3,56
8	364	165 km	310 km	4 340 km	5	3,50	0,41	0,44	8,54	7,95

The free port of Rouen has :

.two pontoon derricks of 150 and 50 tons which together can handle up to 185 tons.

.a RO-RO platform which can support up to 400 tons.

The Port of Marseille has two floating derricks of 90 and 150 tons and from October 1977 on, there will be a third floating derrick of 600 tons.

The FOS installations are equipped with a quay, which is used at the present time by a land crane of 500 tons ; moreover, the port of FOS can accept all ships in service and river barges transporting masses with a unit weight of 800 tons.

The Port of Bordeaux plans to have a 500 ton derrick.

This port policy is supplemented by the policy of ship-owners which almost always have at their disposal ships equipped with 150 to 250 ton derricks, some of which operate on the regular lines. For loads which exceed this amount and up to 700 tons, there are specialized equipments. The technique of ships for the transfer of heavy loads and indivisible loads develops very fast (RO-RO ships, barge carrier ships, towed barges).

In present conditions : /82

.The handling of heavy and bulky loads in the main European ports doesn't present any serious problems. The upstream transport is carried out by land route or by inland water route, although the Service d'Etude Technique des Routes et des Autoroutes (Road and Highways Technical Research Division) had to ensure a convoy of 860 tons.

.Sea transport, considering the number of boats available, can can be carried out without any problems.

The problems are found :

.During the pre-routing toward the European port, when there are weight or clearance limitations, especially when the points of origin are not located near a water route.

.At the level of transshipment in the port of the country of destination, which in general is not equipped with adequate handling equipment.

.During postrouting up to the site where the goods are to be delivered. The site is often isolated and underserved with respect to infrastructures for surface transport.

Studies carried out by the GIE Dirigible, then by Aérospatiale

relate to a stream-lined dirigible of 2,000 km radius of action, 120 km/hr of cruise velocity (without wind), capable of stationary flight, and have made it possible to compare modes of surface transport in eight concrete cases described by the following table.

These studies authorize the GIE to state :

a) that for eight examples comparing global transport costs for heavy loads, the mission performed by the dirigible would turn out to be, in France, about four times less expensive than for surface routes.

b) that foor "door-to-door" transports of containerized freight, the cost of the transported kilometer ton (TKT) should not exceed 0.80 F on the basis of a yearly use of 4,000 hours per year.

The estimate made by the GIE Dirigeable and Aérostatiale can naturally be disputed, and can also change with time. The estimated costs with the quadrilobate device are twice as much as those obtained subsequently by the streamlined shaped dirigible.

The estimates made for other projects are very variable. The table below attempts to group and briefly bring up-to-date the operating costs of the ton/km of a certain number of projects. /84

NAME OF PROJECT	YEAR	COMM. LOAD	COST AT TON/KM UPDATED
AERON CORP.	1968	120 t.	0.60 F
CLAUDE C. SLATE	1968	110 t.	1.20 F
MORSE	1968	135 t.	1.00 F
ECOCENTRE	1972	500 t.	0.35 F
VON VERESS	1973	200 t.	0.25 F
GRUE VOLANTE	1975	50 t.	1.00 F
	1975	500 t.	0.30 F

With respect to heavy and indivisible loads, the cost per ton/km has no relative significance, since the cost by surface route depends on numerous cases, if not uniquely on the "auxiliary" charges and, in particular, on the development of itineraries over distances, which often are numerous short-distance trips.

2.1.2. Commercial Freight Transport Missions

The cost of transport by dirigible can only be estimated at the present stage of its development with a large margin of inaccuracy. It may be assumed, nevertheless, that in terms of kilometers, it is

substantially above the cost of road transports, except in extreme cases, and especially railroads when there are mass transport infrastructures, and quite substantially below the cost of air transports.

Studies of Lightspeed give the following results in ¢ US per ton/km.

Dirigible	0.04	to	0.19
Airplane	0.05	to	I
Helicopter	1.5	to	4
Cargo	0.02	to	0.08
Railroad	0.03	to	0.06
Truck	0.09	to	14

In these conditions, the competition between the dirigible and land means of transport shall be presented in the following manner :

.If a surface transport infrastructure with heavy traffic permitting direct transports exists, or if this infrastructure is warranted by the traffic and if its cost is not excessive, the transport dirigible will not compete with the surface transport.

.On the other hand, if the surface transports are not possible, or if they require complex and costly itineraries, or if the discontinuities in the flow of loads results in considerable increases in cost and time, or if the traffic does not warrent the investments required for establishing or improving heavy surface transport routes, the dirigible has every chance of becoming an acceptable solution.

The comparison will undoubtedly be easier to make between airplane transport and dirigible transport, as long as the aeronatical equipment will make it possible for "door-to-door" service, which is the advantageous characteristic of the dirigible. The fact that the infrastructure required for heavy cargo airplanes is far enough from the point of destination and therefore does not make it possible to avoid discontinuities in the flow of the load, the dirigible, which ensures door-to-door service will be more advantageous. But the air transport streams, often correspond to tonnages which do not warrent the offer of capacity, which the long-distance, heavy cargo dirigible could make.

In fact, the most realistic method of justifiying the use of the dirigible lies in concrete cases where the transport is or could be provided by surface routes. We have presented a few cases below : /86

The IBRD,(1) in particular, has considered the use of a dirigible, called H2, constituting an extrapolation of Hindenburg and the characteristics of which would be as follows :

	HINDEBURG	H2
.Volume	216 000 m3	266 000 m3
.Total weight	206 000 kg	266 000 kg
.Weight when empty	113 000 kg	133 000 kg
.Commercial load	93 000 kg	133 000 kg

The cost calculations for such an aircraft, give the following results compared with the costs of a 15 ton aircraft and a 2 ton aircraft, also studied by the IBRD.

	DIRIGIBLE of 133 tons	DIRIGIBLE of 15 tons	DIRIGIBLE of 2 tons
.Cruising speed (km/hr)	129	130	130
.Commercial speed (Km/hr)	113	110	110
.Characteristic distance (Km)	1 290	220	220
.Flight duration (hour)	11.4	2	2
.Paying commercial load (t)	121.7	11.25	1.50
.Productivity (t/km per hr)	13.752	1.238	165
.Direct operating cost (cents per t/km)	1.93	9.4	38.2
.Total cost (including commercial expenses and financial expenses per t/km)	5.71	27.7	100.2

Source : data provided by the IBRD by the Studien Gruppe Luftschiffbau und Anwendungs Bereiche

Use of the H2 For Serving The Isolated Area of Katanga

Cost comparisons have been made between a Katanga-Lobito connection ensured by the dirigible, and the present system of transport is composed of three sections :

.Railroad between Kinshasa and Port Francqui	1 430 km
.River barge of Port Francqui to Kinshasa	800 km
.Railroad from Kinshasa to Matadi	366 km

Account taken of the type of traffics, we have considered that the dirigibles should be used at full load ; furthermore, the temperature conditions and terrain of the regions crossed are good.

(1) Roles for Airships in Economic Development (George J. BEIER and Gérardo C. HIDALGO - 1975).

The costs of surface transport take into account the direct operating costs of surface transport equipments (railway and barges), of the additional cost resulting from additional traffic, including administrative expenses and maintenance, the cost of vehicle depreciation ; on the other hand, account was not made of the fixed administration costs and maintenance costs, nor of the new infrastructural expenses.

The calculation of transport costs by traditional means, established in 1971, and corrected in 1974 to take into account the increase of fuel cost, gives the following results :

	US $ per ton
.Katanga-Port Francqui (rail)	40.89
.Port Francqui (rail)	5.95
.Port Francqui-Kinshasa (river)	7.36
.Kinshasa (discontinuity in load flow)	5.95
.Transport cost	66.33
.Auxiliary costs	5.04
.Total cost of transfer per ton	71.59

Source : BCEOM, Etude de transport de la Voie National, October 1971

The cost by surface route of $ 71.59 is comparable to the transport by dirigible of $ 73.6 (5.71 cents on 1 290 km). The difference, then, is very small, especially since the cost of conveyance by dirigible includes depreciation. If the depreciation were included in the surface transport, the advantage of the dirigible would be about 15%.

Accordingly, the comparison made for Katanga takes into account the distances to cover and it is obvious that at an equal distance and if a direct and specialized infrastructure is available, the dirigible is no longer competitive.

Furthermore, the cost of fuel takes up only 15 % of the total cost of transport by dirigible; which makes this latter means of transport even more advantageous, since the cost of fuel is high, and it takes up 35 % of the total cost by competing modes of transport.

Finally, it is difficult to compare transshipment costs at the ports : if it is possible to land the dirigible, the transport cost would be much lower than the rail-sea transfer.

Use of the H2 for the Development of Farm Production in Kenya

From 1969 to 1972, the traffic of fresh produce multiplied from

to 8, and reached about 8 000 metric tons between Nairobi and London, with the air tariffs used varying from $ 0.35 to $ 0.48 per kg (IATA) in the direction S.N. At this tariff rate, the traffic was considered likely to expand substantially.

The cost of the ton/km stabilized between 7.08 cents (IATA based tariff) and 5.16 cents (contract tariff), compared to the 5.71 cents expected by the dirigible H2.

The feasible dirigible tariff stabilized, then, at a promotional tariff rate, which facilitated the expansion of fruit and vegetables, and at a considerably lower level than the normal tariffs of 18 cents per ton/km.

It should be pointed out that the use of the dirigible would cause a few problems because of its capacity, which is likely to be excessive both at departure and at arrival and to its slow speed and risks of irregularity, since the time of arrival is important.

Finally, the dirigible is hardly competitive when the traffic warrants the use of a full-time standard cargo airplane, since the aeronautical ground equipment is already quite developed in the region served. It should be pointed out, however, that the ground equipment available to long distance airplanes is not necessarily close to the regions of production.

Use of the Dirigible for Service to the Isolated Area of Burundi /89

The dirigible is used particularly for the transport of nickel ore to Dar Es Salaam.

The mining production may be estimated at 30 000 tons of metal or at 45 000/50 000 tons of concentrate.

The possible solutions are as follows :

.Road construction of 160 km between the mine and Lake Tanganyka, transport by barges over the lake (320 km), transport by rail over 1 200 km, approximately, (East African Rail Road, to Dar Es Salaam).

This system of transport is comparable to the one used for Katanga, but its installation requires considerable investments (road of 160 km and fleet of barges on the lake). Moreover, the time required to ensure this form of transport should be quite long.

.Railway construction of 350 km to connect with the existing East African Alrways.

Considering the difficulties of the stretch to be crossed, and consequently, of the railway construction cost, the latter is warranted only if the traffic would exceed 30 to 50 000 tons (amount forecast), as the annual interest of the amounts invested for the railway construction are about three times the cost of conveyance by dirigible.

.Construction of aeronautical ground facilities near the mine capable of permitting the access of cargo airplanes.

It was estimated that the cost of transport is comparable for the cargo airplane and the drigible, but the cost of constructing aeronautic ground equipment and the cost of transshipment make the dirigible more interesting.

In the case like the one for the evacuation of nickel from Burundi, it is obvious that the indirect advantages resulting from the installation of a surface infrastructure may compensate the advantages of the dirigible.

Use of the Dirigible For the Development of Andine Regions /90

The geographical structure of the Andine region (Peru, Ecuador, Columbia and Bolivia) is characterized by a juxtaposition of isolated valleys, the development of which is prevented or held back by the lack of ground communication facilities.

The installation of a road network, its maintenance and its periodic reconstruction due to climatic conditions, along with the construction of aeronatical ground equipment for conventional airplanes appears as a costly solution.

According to the calculations made in 1972, a dirigible with a commerical load of 15 tons, corresponds to a cost of $ 0.30, approximately per ton/km, compared to US $ 1.50 for a helicopter and US $ 0.60 for a DH Twin Otter. A dirigible of 2 tons of commercial load would have a cost price of US $ 1 per ton/km.

By comparison, the cost of road transport was about 25 to 30 cents per ton/km.

The dirigible appears, then to have an acceptable cost, to the extent that it is used to serve isolated valleys and short distance connections between the valleys are served by an existing road system, the railway and navigable rivers.

Besides its acceptable operating cost, the transport by dirigible offers the advantage of mobility, adaptation to the tonnages transported and requires very little ground equipment.

In this case, the decision relating to the choice of the mode of transport must take into consideration the indirect advantages, but considering the distance of the road networks planned, their cost in mountainous zones (a secondary transport route, the cost of which was estimated at 30 000 $ per km, should be added to the main roads, the cost of which was estimated at 150 000/250 000 $ per km in 1972, and the construction times, the advantage of the small tonnage dirigible seems large, in the choice the development planners have to make.

As a matter of fact, the problem is presented in the following terms :

.Develop or not develop the zone

.Start the development projects immediately without waiting for the installation of surface infrastructures : this development may be ensured with limited aerial equipment and adapted to its development. The risk is then limited, since the transport means may be used in other regions.

.Risk large investments for road infrastructures, without being sure of the development success, which would be slowed down itself until the connections are provided.

The Transport of Spare Parts Between Mulhouse and Kaduna /91

-carried out for Peugot -

The traffic planned shall be about 50 000 tons in 1981. If it is based on a commercial load of 500 tons, 100 trips would then be required over a slightly longer distance than 4 600 km from Lyon to Kano : 5 100 km approximately that the dirigible could make without load flow discontinuity, factory to factory.

Theoretically, the dirigible flying at 130 km/hr, could make 85 trips per year - (40 hours of flight and 5 hours of landing time at each end). It may be assumed that, since the loading and unloading periods can be long and searching for the return freight can require additional time, two full time aircrafts should be used.

The comparison between the heavy cargo airplane and the dirigible may be based uniquely on the freight during descent, which would make up the main load, but we know that the freight during the climb is generally heavier than during the descent, even if it doesn't have as high of a transport cost.

To be acceptable, the dirigible must allow for lower cost-prices than possible by the present system, i.e. 4 600 km airplane and 500 km road, plus transshipment and storage costs at airports, if it is assumed that the handling operations in the factory at the departure and upon arrival would be identical in both cases.

It is certain that in cases of a trasnport by dirigible, 50 trips per aircraft leads to 80 X 50 = 4 000 hours of annual use, which corresponds to very good operating conditions.

In the case of a service porvided by a dirigible having a high annual use, the cost per t.km airplane constitutes the maximum cost which the heavy cargo dirigible must not exceed.

2.2. THE MEDIUM DIRIGIBLE OF 50-100 TONS - (POSSIBLY MORE)

In countries with a developed surface transport infrastructure, the handling operation and average load transports of about 100 tons do not cause any particular problem, generally, with respect to their weight.

Their dimensions and transport frequencies, however, may bring about difficult questions to be solved by traditional surface transport means.

A few cases are presented below :

The Use of the Dirigible for Construction

The Soviet studies mentioned in Chapter 1, bring to light a large market, particularly in North Siberia where the dirigible may be used as a means of transport (taking the place of road transport), as a handling device (taking the place of land hoisting devices). Furthermore, the dirigible may be directly integrated into the "manufacturing chain" of vessels.

This market is certainly a large one, but the remarks of builders of temperate zones and the development of techniques over the past few years should be examined critically in light of the Soviet studies.

Construction by three-dimensional components, which was recommended ten to 15 years ago, appears to have limitations, especially since the technique results in uniform vessels (lack of architectural research), and use must be made of local trades, and finally because the addition of progress in retail (electric cranes, concrete ready-to-use, simplification of connections, use of components easy to assemble, etc ...) results in a considerable increase in productivity of the traditional construction, which becomes comparable to the industrialized construction.

In this context, we are returning, therefore, to a construction by two-dimensional components, which brings about only problems which are easy to solve.

Finally, for political and psychological reasons, at the regional and national level, an attempt is made to integrate as much as possible the local workers into the construction process of vessels.

In developed countries (European or American), there no longer seems to be a generalized or systematic use for construction, which requires the transport of three-dimensional components, which cannot be transported by surface route. The dirigible shall therefore be reserved for exceptional type constructions (construction sites which are difficult to reach, or components which are heavy or which have large dimensions.)

In developing countries, the trend to use local workers is also in hand, but the desired construction rates are likely to be greater than the possibilities of this labor.

In this situation, the prefabrication of three-dimensional modules shall once again play an important role :

.In cases where a uniform construction may be selected from the architectural point of view (in developed countries, it is difficult to accept the repetitive construction of hundreds of uniform suburban homes).

.In cases of scattered industrial relocations (If the construction of 10 000 identical houses cannot be accepted, even in developing countries, at least the construction of schools or uniform public buildings made by putting standardized modules together will be allowed. The weight should amount to about 100 tons, and they will be transported to the site : In the case of Saudia Arabia, for example, there is a program for the construction of 300 schools which could be made by assemblying modular components which would be transported over a maximum distance of about 500 km).

.When there is a lack or a deficiency in the transport means or if the meterological conditions prevent them from being used during long periods of time (flooding, freeze, snow, etc ...).

.In the case of labor shortage.

These conditions are combined in a few regions where development or operation is planned to take place during the next few decades.

.Development of Amazon regions, which imply the construction of numerous urban centers, of various sizes, but which are scattered, as labor is imported form the North East regions).

.Creation of new cities in desert areas, particularly in Africa (Egypt) and in the Arab countries.

.Development of the Arctic regions (North Siberia, North Canada, Alaska) where the conditions described in the Soviet study are found and particularly the various Scandanavian factors of price increase.

.Development of the Antarctique, of which the energy, mining an and food resources seems to be large, although they are still not utilized : the development of these regions can only be accomplished by air means and most likely with a minimum of labor.

Even though it is still not possible, in the conditions presented, to make comparisons of the transport cost, we can at least mention that the dirigible would eliminate at least part of the factors which increase costs, such as the transport and lodging of workers, the construction of temporary road infrastrucutres, the installation and operation of special transport equipment. /94

The Use of the Dirigible for the Construction of Linear Infrastructures

The construction of linear infrastructures on very long distances in regions with difficult access and with small population, results in considerable investments, very long time requirements

since the construction has to be made ahead of time, the use of large amounts of manpower and equipment input : this may be for long-distance gas pipeline and oil pipelines (Alaska, North Canada, Near East, off shore deposits, etc ...), railsroads (transgabon, second transsiberian), energy transport lines (from nuclear plants, large hydroelectric plants of Latin America, etc), teleferic mineral transporters, etc ...

The conditions in which such construction sites are operated give cause for cost increases, of which the following are a few examples :

.The need to transport materials by road leads to the construction of a temporary infrastructure, which is used and abandoned; it must nevertheless have an adequate bearing capacity for heavy freight trucks and therefore incurs high costs.

.Even if heavy freight trucks are used, it is necessary to limit the tonnage of convoys for reasons of weight and bulk : the pielines are transported in sections of 10 to 20 meters maximum. Rails and rail ties are not assembled. High-voltage pylons are transported in detached parts, etc ...

Consequently, it is necessary to carry out operations on site (welding, assembly) which should be performed faster, more efficiently and more economical on a main construction site where large teams are kept and therefore the working conditions increase the cost, lodging must be provided, but it is abandoned afterward.

.The necessity of constructing infrastructures ahead of time increases the duration of the works and causes capital to be tied up for very long periods causing delays in the operation of a deposit.

A system of transport by dirigible would make it possible to /95
avoid these causes for cost increases, for example, by ensuring various operations at main construction sites (welding of pipe-lines in the factory, of rails to rail ties, pylon assembly, etc ...) with a more economical labor, by eliminating the need to construct a road infrastructure, by avoiding the construction of temporary lodgings.

In these circumstances, the cost price per ton/km of dirigible can only have a very relative value : in fact, the installation of a transport system and construction by dirigible would cause the concept itself of a construction site to be changed and would have effect not only the transport cost of materials and personnel, but also various other elements of the cost-price : for example, a reduction in the number of specialists and an improvement in working conditions would result in over-all decrease in salary costs.

In this situtaion, it should be determined if, and in what conditions the dirigible may be integrated into a construction process, then a cost estimate should be made on the concrete project.

At the present stage, only a preliminary study, similar to the one carried out with EDF and reported below, can be made. It relates to the construction of very high-voltage lines which is causing greater and greater problems.

.Due to cost increase of specialized labor resulting from the assembly of pylons.

.Due to environmental constraints (clearing the region, particularly in forest zones).

.Due to sometimes quite high indemnities resulting from crop destruction during the construction of high-voltage lines.

The installation of electrical pylons is an area which is difficult to make estimates on, but it is an essential part of the transport of light metal structures.

Other cases may nevertheless be considered relating to the operations over long-distances (pylons teleferic) or point to point operations (radio-electric stations, television, etc ...).

Account taken of the present methods of constructing high-voltage lines in France, the dirigible could be used on three levels.

Level 1 /96

The dirigible is used as a means for transporting materials to the pylon relocation site, from the warehouse, which in most cases is at a railroad station.

It is then necessary to assemble the materials (aggregates of concrete, metal bars, insulators and accessories, etc ...) and all of the assembly equipment (earth-clearing devices, compressors, hoisting pasts, etc ...) are transported to the site. The total weight to be transported is variable, depending on the type of pylon to be constructed, but it can in some cases exceed 100 tons. This load may be divided into smaller packages, but a commercial load which is too small would result in a very dense traffic.

The transport of construction materials can be done ahead of time, independantly from the planning of the pylon construction, since they may be stored at the site of use. Some assembly equipment can stay at the construction site only a limited period of time if an optimal use is made. Planning should be made for the transport of personnel and equipment from one site to another during different stages of the construction.

In this case, the methods of pylon construction are not modified, and use of the dirigible will result in a comparison with current cost-prices by land transport and in some cases by air (helicopter), account taken of auxiliary expenses.

Considering the low cost of rail transport, the dirigible cannot be used to take the place of terminal transport, which is

usually ensured by road, except when large tonnages are to be transported, of which a partial unloading is made at each of the sites. The dirigible could then take on the metal parts of the pylons at the metal factory and the aggregates at the cement factory and transport them all to the construction site.

Level 2

The dirigible is used as a means of transporting materials and equipment, as in the preceding case, then as a means for hoisting the ground-mounted pylons, when topographical conditions are satisfactory.

This assumption makes it necessary to transport earth-moving devices, but not hoisting devices. Large ground surface is required (rotation mounting), and the method is likely not be become generalized for topographical reasons, many pylons must be mounted ahead of time.

Level 3

The dirigible is used as transport and handling equipment for pylons which are mounted completely outside of the relocation site.

Several assumptions may be considered for the location of the /97
assembly center, but difficulties relating to storage are likely to be encountered for the assembled pylongs, which take up a large surface area when lying down. Furthermore, it seems necessary to store a large number of pylons if an optimal use of the dirigible is to be made. It should be pointed out that, in this situation, the number of aerial assembliers would be reduced. They should be substituted by a fixed personnel, which would have detrimental effects on the cost prices.

Three assumptions relating to the location of the hoisting site location may be taken into consideration :

Level 3 A

Use of the currently selected storage sites, according to current criteria, i.e. in a train station, or very close to a train station, if available surface area make it possible, which is not always the case, but advantage shall be made of the low railway tariffs.

Level 3 B

Use of independant assembly sites not connected with road or rail transports, which must be supplied by a new mode of transport, which could be water or air routes, by use of heavy cargo dirigibles. The assembly sites selected could take up a very small area, but the construction sites must be permanent and should be very large.

Level 3 C

Assembly in the factory : this would make it possible to install assembly lines and, possibly, an up-right storage. The dirigible could transport the pylon directly from the factory to the relocation site.

This does not seem to be a realistic plan, given the conditions presented by the EDF.

In all three assumptions, the excavation works, installation of bases and concrete foundation works naturally must take place at the site. This requires the transport of cement and of aggregates, as well as of excavation equipment. In any case, it is obvious that there will be ground damage, but it is imperative that the pylon is set up in a very accurate position. Moreover, it is indispensable for the operations of setting in the pylons to be completed at a fast pace.

Summary Description of the Dirigibles Required, Account Taken of Preceding Conditions /98

Description 1

The transports shall be for divisible tonnages in several packages ranging from 20 to 100 tons (metal parts, concrete, excavation and handling materials). The transports shall be over short distances, reaching a maximum of several tens of kilometers. The accuracy of the set shall be average, as the dirigible shall not be involved in the pylon assembly operations.

The use of the 15 ton dirigible may be used in this situation and its application will depend on its operating cost : its use is possible and profitable for the transport of materials to sites with difficult access for topographical reasons or environmental reasons rich crops, forests, etc ...). Depending on the year, 2 to 5 % of the pylons should be warranted in France through this type of supply process for construction sites. This percentage should be higher in some developing nations. A cost comparison will allow for a conclusion to be made regarding the feasibility of general use of the dirigible in sites without difficult access.

Description 2

As soon as the dirigible is used as a handling device, it must have a bearing capacity applied to the weight of the metal part of the pylon. Even if the pylon is transported over short distances, or in the case of a simple rotation, the same bearing capacity is required as for the winches which are currently used.

It should be recalled that the present techniques of assembly by rotation are used only for pylons reaching a maximum of 30 meters of height and 4 to 5 tons, but these characteristics may possibly be exceeded. In the case of assembly rotation operations, with the pylon being held by the ground, a dirigible of 15 tons of

commercial load should be able to set in place a large number of pylons often used today.

Description 3

In the three descriptions presented under this title, the missions planned are for earthworks and foundation works on the one hand, and for the actual setting in of the pylons.

The transport of public works materials and materials required for ensuring description 1 may be provided by dirigibles with a commercial load of 15 tons.

On the other hand, missions for the transport of pylons alone require different characteristics.

Description 3 A

/99

The commercial load must permit the transportation of most of the pylons frequently used : a commercial load of 30 tons should allow for the transport of 50 %, approximately, of the pylons set in France. A commercial load of 75 tons should permit the transportoof 96 % of the pylons set. The rest are used for very special cases.

The radius of action of the dirigible can only be very small, since the assembly site is located only a few tens of kilometers at the most, from the relocation site.

The degree of accuracy of the set shall be high (one tenth of a centimeter), the setting operation must be very brief and require a minimum of specialized personnel (1). It is undoubtedly possible to guide the pylon to the ground so that the four corners are set in the base , but it seems excluded that the dirigible is hooked to the ground, which would require the presence of several workers. Due to the shape and structure of the pylons, which must be held by "ears", for protection from pendular mtion during transport.

Description 3 B

There are two transport problems :

.The transport between the assembly park and the relocation site : the commercial load characteristics must correspond to the conditions in description 3 A ; a commercial load of 30 tons shall allow for 50 % of the pylons to be set in, but since the assembly parks are not in the same location as in the preceding case, as they are larger and must serve larger zones, the distances to cover to transport the assembled pylons shall be longer and could exceed 100 km : we can imagine,for example, that to "cover" the entire French territory, about 10 assembly centers would be required and should be selected in connection with the relocation plan for the EDF lines.

(1) special techniques must be perfected (funnels, for example).

.The transport of materials from the factory and the assembly center : since the assembly center is established in a zone which is not served by the railroad, and is inadequately served by road, it will be possible to plan for supply by air route, but in this case, and for reasons of profitability, the transport of supplies may be provided by a dirigible with a high commercial load. The capacity of 500 tons may therefore be selected.

The difference between the cost-prices of railroad, road and air transports may be at least partially compensated by the facility in selecting the assembly location, by its low cost, by labor savings, etc ... /100

Description 3 C

The assembly in the factory may be planned as long as it is possible to store the pylons up-right through permanent installations. The pylons may therefore be removed during their assembly and distributed as needed to the various construction sites of high-voltage lines. The commercial load characteristics should be the same as for the two preceding descriptions, but the radius of action should naturally be higher, especially if it is not possible to select the suppliers of materials as a function of the relocation of the high-voltage lines to be constructed.

This is not a very probable situation for the EDF.

In summary, a first examination for a use of the dirigible for the construction of high-voltage lines makes it possible to consider a whole series of dirigibles, ranging from a commercial load of 10 tons (supply of the sites) up to a commercial load of 500 tons (supply of the assembly sites).

An implementation plan drafted by the Soviet engineers allows for the use of a distribution center, ensured by a group of five dirigibles, each one of which is given a specific task to accomplish in each stage of the plan.

The first dirigible transports the earthworking machines and drilling machines o prepare the excavations for the sockets supporting the pylons.

The second transports concrete sockets, ready to be used, or if the concrete is prepared on the site, the dirigible will pick it up where it is produced.

The third dirigible transports the pylons.

The fourth one is for the assembly of insulators and wires.

The fifth dirigible transports workers, plays the role of auxiliary transport and ensures the connections.

The loading capacity of the aircrafts belonging to this group may be 20, 20, 100, 20, and 10 tons, respectively. /101

Use of the Dirigible For the Transport of Lumber in Equatorial Countries

Forestry operations are composed of various stages described in the following paragraph (page 102), for most of which the cost of the dirigible must be compared with that of the complex and costly materials which are the crawlers or Skidder tractors.

The logs are then grouped in loading parks where they are usually transported by road.

In the case of absence of a road system and the impossibility to construct one (swampy areas, for example), it is necessary to plan for an evacuation, which may be provided by a dirigible of 50 to 100 tons.

In the case of Gabon a fleet of about 10 aircraft with a commercial load of 50 tons has been considered.

Use of the dirigible for this mission would make it possible to work forest areas which are vast and have a scattered population (Northern Congo, Zaïre, Amazonas), but the operation of which does not warrant the construction of a road system, for topographical reasons and due to the dispersion of rare varieties of trees.

It is obvious that the use of the dirigible for this type of operation may be considered only where transports by surface routes are not possible.

2.3. THE SMALL DIRIGIBLE - (10 - 20 Tons) /102

Dirigibles of 10 - 20 tons compete with the helicopter having larger commercial loads, with the airplane, boats for various surveillance and exploration missions, land or maritime handling devices.

The possibilities of use are numerous and only when the characteristics are defined can the scope of activities of this type of equipment be defined in more detail.

We have selected below several types of missions :

2.3.1 Use of the Dirigible for Lumbering in the Equator

Lumbering operations may be analyzed by a certain number of tasks as presented below :

Exploration and Inventory of the Forest

Compiling cards on which are recorded geographical constraints

rivers, river channels, type of ground, etc ... and where the trees to be chopped down are mapped out.

Civil Engineering Works and Miscellaneous Works Prior to Beginning the Operation

Road and bridge construction and implementation of other works, which are not immediately productive, but which involve large investments :

.under-brush removal at basic camp
.construction of the first huts
.initiation of systematic exploration
.construction of runway
.performing earthworks of export park
.assembly of mechanical shops
.assembly of warehouse for spare parts, etc ...

Chopping Down and Discharging :

Tree chopping in itself does not present any problems and it is not expensive.

The composition of the crews vary with the operations and the regions (3 to 4 men with equipment). A timber yard has 7 to 10 crews. The discharging takes place in two operations : removal by caterpillar tractor or wheeled tractor. The caterpillar or wheeled tractor discharges the tree over short distances (500 m approximately), to a park where the tree is cut off. The logs are again discharged by skidder (wheeled tractor) over about 1 500 to 2 500 m maximum up to the loading park along the road.

Rolling or Road Transport

This operation consists of transporting the logs from intermediary parks of the forest to the main export park, which is generally along a river, railroad or the sea. This transport covers a few tens to a few hundreds of kilometers. The timber is then put into cargo, or if an intermediary transport is necessary, onto a wagon, on a barge for non floatable wood, or assembled into rafts for floatable wood.

Cargo Loading

This loading is carried out directly from the barge, the truck, the wagon or the raft in the case of floatable wood, with possible storage of various durations at the port.

Note

The weight of the logs thus transported is considerably higher than in countries with moderate climate :

	Gabon	R.C.A.	Indonesia
Mini	1 ton	4 tons	2.5. tons
Medium	3 tons	6 tons	4 tons
Maxi	10 tons	15 tons	10-15 tons

Remarks on the Present Lumbering System

The current lumbering system used is characterized by :

.The construction of a large road infrastructure and the installation of large public works equipment, handling and transport equipment.

One of the companies questioned wrote :

"If the use of the dirigible would make it possible to avoid road construction, this would avoid :

-the purchase of highly expensive public works equipment
-the purchase of numerous service vehicles : platform trucks, bowls, bulk transporters, land rovers, etc ... /104
-the need to have maintenance and repair shops which are elaborate
-large quantity purchases of fuel and lubrications
-need for storage of spare parts

For materials, this constitutes about 80 % of the investment.

Moreover, the personnel would be decreased considerably.

In Indonesia, we have 150 mechanics and 4 to 5 immigrant workers, including 1 engineer, one hundred drivers and assistants, loggers and all types of vehicles, one hundred workers in road construction and maintenance.

This is without taking into account the constant engine and vehicle breakdowns, problems of recruitement and training of specialized local workers in countries without competent immigrants, which is quite expensive and develops serious family problems.

There would be no more constraints relating to surface and natural obstacles : hills, rivers, river channels, etc ...; areas which are not worked at present would become accessible.

Intermediary roads and parks are harmful for plant and animal life, the latter of which is chased away by noise.

Lumbering which is currently a public works activity and transportation involvement, would be routed toward the forest.

It would be adequate to build a basic camp with minimum material, and to clear an adequate surface for the export park, to build an air runway and to spend a few months exploring the region before commencing the operation.

This would entirely revolutionize this profession."

.Long time required for commencing an operation.

One of the firms questioned considers that "One or one and one half years of preparatory works are necessary before a lumbering operation takes off". This duration has a financial translation because the costly discharging equipment, transport and handling equipment must have already been purchased.

.Lumbering is currently mainly a public works activity (road construction) and a transport activity. Furthermore, it should be pointed out that many administrations of tropical countries use lumbering operations for the creation of their road networks and for their maintenance which puts heavy social and economic burdon on the forestry sector. /105

.Unsystematic working of the forest.

The present system results in avoiding operations in areas difficult to reach (swampy areas, for example), avoiding the treatment of varieties, which are sensitive to insects and fungus, to long transport periods, to extended periods in the water.

Accordingly, lumbering has a very extensive characteristic in some regions : the operation of the Cameroons removes only 2.5 to 5 m3 of lumber per hectar which is exported and 10 to 15 m3 for machining in the country.

Lumbering load weights are therefore very heavy : the transport over one kilometer of road gives on the average only 300 m3 of wood in the Cameroons, compared to 100 m3 on the Ivory Coast and in the Gaboon.

Integration of the Dirigible

One of the operators questioned wrote :

"The integration of the dirigible into the present system does not seem possible, as it is limited to zones which are difficult to reach and to the transport of personnel; it does not eliminate the main cost centers which are :

-discharging
-rolling
-road construction

and therefore the use of a costly equipment to purchase and maintain.

It is therfore likely that the first experimental operations will be limited and will concern zones with traditional equipment which could not be used. Only after such experiments can the systematic use of the handling and transport by dirigible be integrated.

Such an integration should modify the conditions and principles themselves of forestry operations in Equatorial countries.

Any technical progress, however, which seriously threaten a profession, conflicting with work habits, shocking thinkers and frightening financiers if the proven success is not approximately 100 %". /106

Numerous questions will be answered before the systematic operation of the dirigible is implemented ; it remains to be known, for example :

-What investment is required for several dirigibles, which could produce a cubic volume corresponding to the previously mentioned amount, and having hoisting capability of about 15 to 20 tons?

-What would be their maintenance and operating cost ?

-What would be their behavior during the rainy season, or during tornadoes and other meteorological incidents characteristic of the Equatorial countries ?

-What would be the reaction of developing nations if the foresters no longer built roads ?

-What would be the reaction of the countries themselves if the foresters no longer train their workers and kept only a minimum of unqualified labor ?

-What would be the psychological reaction of accidents, which are inevitable regardless of precautions taken, and even though they are not as numerous as with traditional equipment, they would have a more spectacular impact?

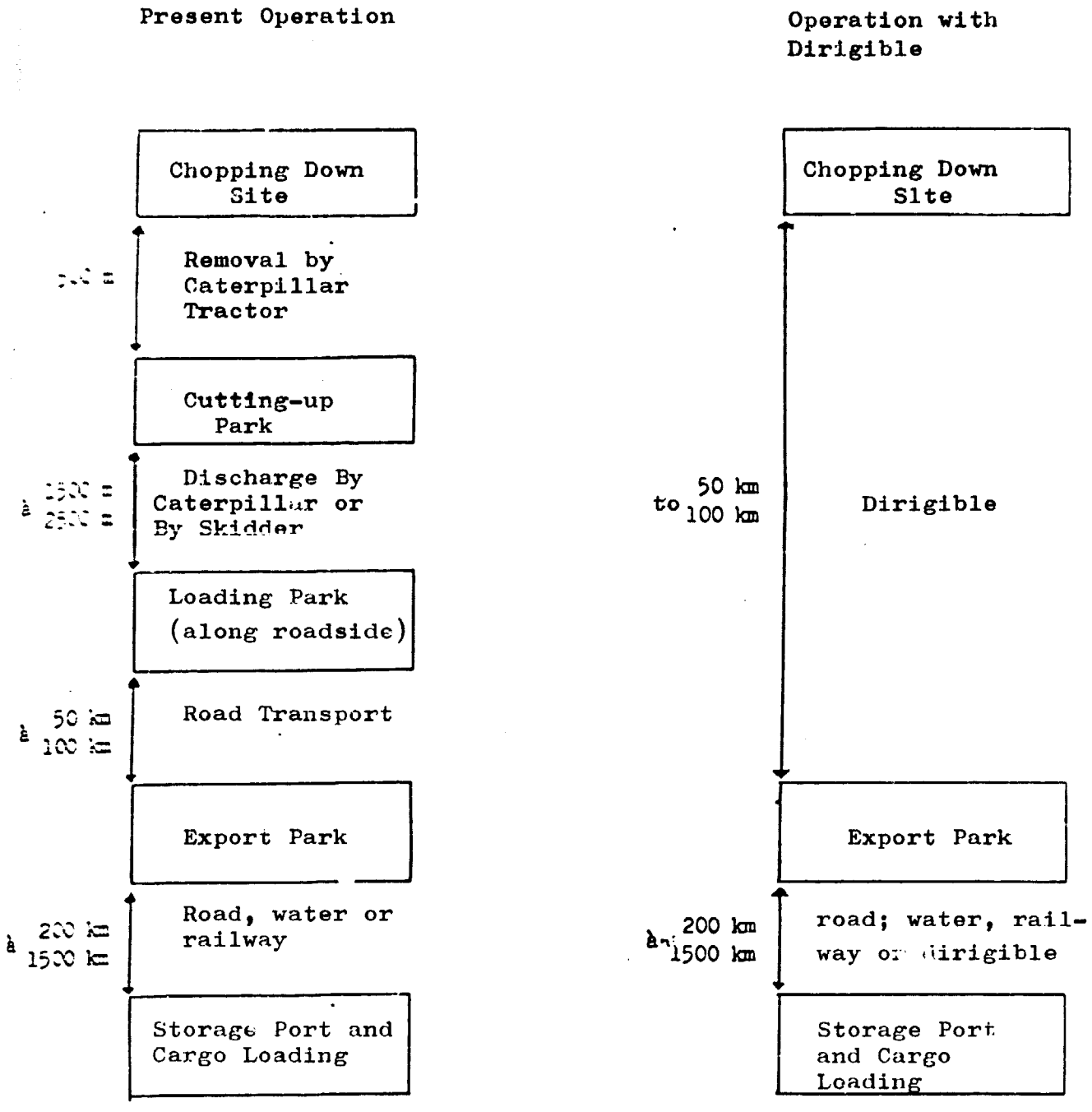
The problem of integrating the dirigible is, then, presented in terms of general planning and economy, as well as in technical and management terms relating to lumbering operations.

In order for the dirigible to be fully warranted, it must be capable of eliminating the operations of removal, discharging and rolling up to the park where the trees are prepared for export.

Accordingly, a certain number of account items for operation shall be eliminated : pulling equipment, construction of local roads which have no economical justification.

The lumbering operation plan shall develop, then, as is shown on the diagram of the following page :

The main result of an operating plan including the use of the dirigible would be the elimination of the operating road system and the costly discharge equipment. /108



Even if a definition is made of the operations which would be eliminated by integrating the dirigible into the cycle of operation, it would not be as easy to estimate the effects on costs, and then to implement its general use.

Each operation has, in fact, its own characteristics connected to the country in which they are found ; labor cost ; border tariffs on imported products ; fuel of spare parts ; tree species ; width and density ; working method ; removal by caterpillar tractor requiring dense road system or discharge by wheeled tractor for which a path is adequate, etc ... Moreover, cost analysis varies from one operator to another.

We have presented below a concrete example for an operation in Indonesia ; considerable differences may exist from one country to another.

The chopping down operation itself does not present any special problem and it is not costly, besides the fact that it is necessary to transport the crew of tree choppers to the work site : a crew of choppers includes two to three members which chops on the average one tree per hour.

The average cost for chopping and removal of a tree may be estimated at 110/120 F, including the crew transport costs, of which 20/25 F corresponds to "non transferable charges" : tree exploration, preparation for the chopping, the chopping itself, topping.

The cost of transport up to the export park may be estimated at 50 F per tree. The distance between the chopping site and the export park is about 50 to 75 km.

Given these conditions, it may be estimated that a tree arriving to the export park will have cost 20/24 F chopping (fixed item) and 140/145 F for transport : removal discharge, rolling. If the estimate is based on an average weight of 8 tons and over a distance of 50 km, we have a cost of 0.35 - 0.40 F per tons/km.

This cost, however, does not include the road construction, and the improvement of the road system constitutes one of the most important items in lumbering operations, even though its amount and effect on the cost-price of wood varies with the type of roads constructed, with the surface area, with the density of the forest to be worked, with the type of soil, etc ...

Furthermore, in the present conditions, only zones which can be operated with current technical equipment are worked. The result is that some rich forest areas covering vast areas, but which are isolared, are not operated.

The road system of the operations may be outlined in the shape of a herring-bone fish, with a secondary road exiting every 300 m from the main road and having a length of 3 km, approximately, from one end to the other. In these conditions, the main road system - secondary road system permits the operation of a zone of 600 ha, i.e. 300 ha on each side. /109

A main road on flat ground, costs about 40,000 F, and twice as much for rough ground. A secondary road costs half as much.

The operation of 600 ha shall cost, then, about :

. 1 km of main road 40 000 to 80 000 Frs;
.18 km of secondary roads 360 000 to 720 000 Frs.

and shall correspond to a minimum production of 4 000 to 5 000 m3 in some countries of Africa to a maximum production of 12 000 to 60 000 m3 in some regions of Indonesia.

If one considers an average cost of 500 000 F for the construction of the infrastructure, and an average production of 20 000 m3, the cost of the infrastructure per ton produced shall be about 25 F.

Furthermore, if the average distance covered up to the export park is about 50 km, the additional cost per ton/km shall be 0.50 F, approximately, which means that the previous calculation is doubled or more than doubled.

At the same time, if account is made of the depreciation of the equipment used for the removal and rolling, the costs per ton/km shall be increased in substantial proportions, and especially since the lifetime of the equipment used, which is very costly, is very brief.

We have estimated, and the estimation is confirmed by the operators, that the equipment depreciation was equal to about one third of the total operating cost.

The total transport cost per ton/km from the site of removal to the export park would be, then, in the example selected, above that for all the cases at 1.20 F and very likely at 1.40 F.

This example does not necessarily have a general value, but it gives an idea of present costs, according to information provided by firms which have the necessary elements available for establishing an analytical accounting, even if this accounting is not made ; and few firms have such data.

It should be emphasized that the costs are naturally very variable within a same geographic zone, since some sectors cannot be worked because of the topography of the sites.

A cost ranging between 1.50 and 2 F per ton/km is likely for the over-all operation, from the chopping to the park.

Besides the problems of cost, we should have a notion as precise as possible of the "pace" of the lumbering operation sites.

In an operation in Indonesia, the production is about 20 000 m3 per month, i.e. about 800 m3 per day. The average cubic volume may be estimated at 8 m3 ; the average diameter is 0.80 m. The

length is 16 m, which corresponds to 2 exportable logs of 8 m. It is moreover necessary to chop down about 100/110 trees to obtain 100 exportable trees.

If account is made that the distances of transport are about 50 mk, it may be estimated that one rotation will take 1 and 1/2 to 2 hrs, which would give 4 to 6 rotations per day. The dirigible shall then transport 1 or 2 trees during each trip, ten to fifteen small tonnage dirigibles should be assigned to such an operation.

The operation taken as an example consists of two permanent work sites, each site has 7 crews which chop down on the average 8 trees per day. If the dirigible can transport 2 trees during each trip, the small capacity dirigible should be assigned to each chopping crew in order to remove the production little by little.

Naturally, if the distances to be covered are small, and if, for example, the dirigible is expected to carry out only discharge operations, which would mean a distance of a few kilometers to cover at maximum, the number of dirigibles required would be smaller, and it may be estimated that only two dirigibles would be necessary for a work site of 7 crews.

Market Evaluation

At the present stage of development, it is naturally very difficult to evaluate what the market for one dirigible of 15/20 tons of commercial load would be, when there are so many unknown. A detailed study at the site should be made in close cooperation with the operators and the administrations in charge.

Before presenting three possible types of operations, it should be pointed out that the systematic use of the dirigible shall very likely curtailed, or even prohibited in zones where it has already been accepted, to the extent that it is directly related to the road system. This explains the need for a general economic development plan, including the transport and handling dirigible.

With this, several types of operations may be conceived of.

Type 1 : /.11

Use of the Dirigible to Operate in Sectors Which Have Been cepted But Not Yet Worked

This is a type of marginal operation, which would make it possible to no longer ignore regions which are not possible to reach for topographical reasons : swamps, flooded areas, rough areas, sectors isolated by a waterway ... The dirigible would not permit savings to be made for discharging and rolling equipment, in this case, but would make it possible to expand the sectors worked due to the construction of main road networks. The number of aircraft required would naturally depend on the types of existing forestry operations and on the geographical environment.

Type 2 :

Use of the Dirigible Only For Discharging Operations

In this case, the dirigible would permit savings to be made for the secondary road systems, which as we have seen involve considerable financial investments, and for the removal and discharging equipment, which is also very costly. The main road, which by itself has economic value in the subsequent development phases of the country, should be maintained, but it represents only 10/30 % of the total cost of the infrastructure.

The dirigible should be used only over distances of a few kilometers, as a handling device, between the chopping site and a determined number of loading points along the main road where logs are to be loaded onto trucks for conveyance to the export park. In this case, it may be estimated that one dirigible would be adequate to serve 6 or 7 crews for chopping , with each crew chopping down one tree per hour, approximately.

Political and economical obstacles caused by the elimination of roads which should be removed, as it is the only main road with an economical and political value.

In this situation, it may be estimated that the transfer of technology, where the skidder and the caterpillar tractor are replaced by the dirigible, which operates over short distances, should be relatively easy and would not present problems for the operating companies.

Furthermore, the operating zone which equals one km of main road is currently about 600 ha, could be considerably increased ; the short distance may possibly reach around ten km : the number of crews served by a dirigible should progressivly decrease as the distances covered increase.

Type 3 /112

Systematic Use of the Dirigible Between Operating Zones and the Park, or Possibly the Treatment Factory

In this assumption the entire road network is eliminated : main roads and secondary roads.

This type may be considered only for zones which are not granted at the present time, nor worked because of topographical reasons (swamp zone of the North Congo or West ZÄire, to give only two examples), or economical reasons (forest in Guiana). We are lead to a profound modification of this type of operation, which may only be considered upon the installation of a new complex.

This could be the case for the forest in Guiana : a few projects for paper-pulp manufacturing factories are currently being drafted.

A detailed comparison should be made right away, based on an estimated cost-price per ton/km by a dirigible of 15 tons, between traditional equipment and the dirigible for providing supplies to the factory.

Summary Characteristics of the Dirigible Required For Lumbering Operations

Program Objectives

Commercial Load

15 to 20 tons of commerical load would allow for most of the trees to be treated.

Distances To Be Covered

A few kilometers, at minimum, several tens of kilometers, at most, but it would be necessary to plan for the fuel supply for once or twice a day.

Stationary Flight

Does not need to land at the tree removal site in the forest.

Meteo Use in tropical and equatorial qtmosphere.

Handling : Needs a very efficient system, very simple and very fast handling.

Infrastructure /113

Limited to one base (factory or export park).

Number of Days of Use

It is preferable that the dirigible can be used permanently, but it is to be observed that this is not always obtained by present means.

Accuracy of Picking Up and Setting Down

A high accuracy is not indispensable, and it should be noted that the chopping crew shall always be at the site during the tree pick-up by the dirigible.

2.3.2. The Surveillance and Exploration Dirigible in Sea Zone

Use of the dirigible above the sea constitutes porbably one of the most promising sectors, and in the framework of sea development & surveillance, large zones of economic and administrative activity are concerned :

Environmental protection : surveillance of sea and air pollution, development of coastal zones.

Equipment : Development of coastal zones, supply of light-houses, meteorological device.

Tourism : Flights over tourist regions.

Transports (Merchant Marine) : navigation surveillance and control to assist sea traffic, ship transfers to the coast and vice versa, determination of fishing zones.

Army : Any seaboard action (200 miles).

Finance : Surveillance of customs.

National Education : Flying classes.

Industry : Development of sea zones (oil, mining activities).

Interior : Police surveillance, civilian protection.

Missions of these various administrations and those of those of firms interested in economical development of the zone have a few points in common :

.Need to transport crews which may be relatively numerous and required laboratory equipment.

.Capability of staying in the air for rather long periods of time, for about one day.

.Weather resistance (strong winds).

.Speeds, on the other hand, may be slow ; but for some flight missions, very slow or stationary flight are indispensable.

.Vertical landing may be desired in some cases, but the short landing shall generally be adequate, since the dirigible shall generally have basic operations at its disposal.

The dirigible used in this sea version shall compete with the /115
airplane (extension of the sea zone to 200 miles has resulted in numerous proposals from aeronatical manufacturers), with the helicopter, with sea equipment and, possibly, with ground equipment or satillites.

The dirigible shall therefore be generally selected by reference to the cost-price of the airplane and the helicopter.

3. THE MARKETS /116

At the present stage of analysis of the problem, it is not necessary to present a detailed analysis of the over-all markets of the dirigible on a world-wide scale.

We have simply attempted to present a description of how the dirigible may be used in a few countries and in a few regions taken as an example. We have selected cases where the cost-price would be

acceptable, with account taken of the implementation conditions.

The selection of the dirigible as a system of transport, displacement and aerial work (handling in particular) shall result in the comparison of various elements of which the main ones are :

.Costs

.Services

.Environmental effects

When the service provided by the dirigible cannot be ensured, or can be ensured only in poor surface conditions, the cost comparison per ton/km loses its meaning, since the cost of surface transport shall be highly burdoned :

.By extending the route

.By discontinuities in load flow and time required for stopovers

.By administrative delays

.By environmental effects (destruction, congestion, development of itineraries, etc ...)

Moreover, surface transport constraints are likely to have strong effects on industrial processes and on the financial structure of industrial operations.

The advantage of the dirigible may be brought to light only after the detailed examination of concrete operations ; but if the comparison of transport operations by various modes may be done, the manufacturers have not studied the financial and technical effects of a modification in the transport system on the manufacturing process : the latter may be quite considerable :

Example :

.Transports of heavy and indivisible masses

.Handling in sensitive zones and at difficult sites

.Operations of construction and public works at difficult sites

When the service may ber perforemed in normal conditions by another mode of transport or by another work process, the notion of cost per kilometer becomes predominant again : /117

Examples :

.Regular transports of bulk products, spare parts where the dirigible shall be in competition with another mode or with a combination of other modes.

.Handling missions of loads accessible to land, sea or air equipment.

.Missions of surveillance and exploration currently provided by air equipment (airplane and helicopter), sea or fixed equipment.

3.1. CASE OF FRANCE

/118

3.1.1. Heavy Cargo Dirigible

.Heavy and bulky loads

Transports restricted to Europe	4 - 6 aircrafts
Long-distance transports (through fuel re-supply)	2 - 3 aircrafts

.Heavy transports for French firms in Africa, in the Middle East and between these regions and Europe :

Supply of farm, forestry, mining products ; supply of assembly chains	4 - 6 aircrafts

.Special uses

Supply of factories (paper in Guiana, evacuation of chemicals, etc ...)	2 - 3 aircrafts

.Miscellaneous :

Containers, off shore, vehicles, passenger transports and cruises	p.m.
TOTAL	12 - 18 aircraft

Comments

The estimate made for heavy cargo dirigibles results from studies carried out within the framework of the GIE dirigible ; an increase coefficient of 50 % was allowed for in the case of a point to point transport by the dirigible, with the possibility of one or several refules during the trip.

The estimate for long distance heavy transports results from th the examination of a few concrete cases : the substitution of the airplane by the dirigible to supply the Peugot factory in Nigeria would require two aircraft, for example. The evacuation of cotton from Tchad would require two aircrafts. Use of the dirigible to evacuate mining products from French firms in Africa would require several aircrafts, as is also the case for a use to supply food products.

Various specific implementations may be considered : supply of chemicals and evacuation of paper-pulp from factories in Guiana, transport of chemicals, evacuation of iron and steel products.

The transport of containers, off shore equipment, boats, vehicles, etc ...

Use of heavy dirigible for cruises has not been estimated.

3.1.2. Medium Dirigible /120

.Heavy and Bulky Loads

Transports limited to Europe 2 - 4 aircrafts

.Transports grouped or not of semi-finished products (pipe-lines, rail road tracks, high-voltage lines, etc ...) carried out by French firms in France and abroad or for needs of the French economy. 2 - 8 aircrafts

.Transports of containers (transports combined with those of French sea companies) 2 - 4 aircrafts

.Transports of tropical lumber (French firms) 2 - 4 aircrafts

.Special Applications

Transport of materials to public transport construction sites - use for prefabricated construction - transports of public transportation equipment for French firms in France and abroad. 4 - 20 aircrafts

.Miscellaneous :

Transports of off shore equipment, of passengers

p.m.

12 - 40 aircrafts

Comments

The transport of heavy and exceptional loads of 35 to 300 tons, according to GIE research, leads to 25 aircrafts. We have been much more modest in order to take into account land competition and we have considered that the medium device would not ensure long distance missions.

The market evaluation of this type of aircraft is generally very delicate due to competition from surface and handling equipments, and is much more sensitive than for high tonnages. The adoption of the "dirigible system", however in some sectors of the economy (construction of linear infrastructures) or in some geographical sectors (Amazone, Antarctic) where French firms shall be interested, may considerably expand the market.

The market for the transport of tropical lumber is also difficult to evaluate : it has been estimated at about ten 50 ton aircrafts for Gabon alone.

Account has not been taken of the medium term possibilites, nor of the market for passenger transports.

3.1.3. Small Dirigible /121

.Light and Bulky Loads :

Construction	10 - 20 aircrafts
Transports of materials to the construction site, construction of linear infrastructures (firms - French - in France and abroad).	10 - 20 aircrafts
.Surveillance, exploration works, particularly in the exclusive economic zone (coastal) and in sea exploration zones	10 - 20 aircrafts
.Passenger transport	2 - 4 aircrafts
.Lumber operations (French firms abroad) discharging of logs	10 - 20 aircrafts
.Miscellaneous Farm Works, tourist transports	p.m.
	32 - 64 aircrafts

Comments

The transport of light and bulky loads and lumber transports constitutes a sector which is likely to expand extensively, due to the savings it can bring about from their use and to a reduction in ground infrastructures for roads.

The surveillance and exploration works, particularly in sea zones, concern numerous sectors of the economy and they are expected to expand at a very fast rate over the next few decades.

The farm sector and tourist transports have not been estimated, due to the diversity in points of view.

Farm use may develop in the extensive crop zone.

3.1.4. Mini-Dirigible /122

.Lumbering in temperate zone	25 - 35 aircrafts
.Small handling operations	5 - 10 aircrafts
.Surveillance, detection, photo, advertizing	10 - 20 aircrafts
.Passenger transport	5 - 10 aircrafts
TOTAL	45 - 75 aircrafts

Comments

The estimate of the lumbering dirigible is the result of studies conducted by Aérospatiale on the Hélicostat.

3.2. CASE OF EUROPE /123

With no systematic survey available in European countries, we should be able to assume that the French market consitutes roughly about 1/4 to 1/3 of the European market.

This estimate may be criticized :

.With regard to the transport of heavy loads, due ot the development of river systems and harbor equipments and to the role played by harbors in the transport of heavy and indivisible loads.

The Port of Anvers, for example, considers itself to be in a disadvantageous position because it is difficult to reach.

.With respect to activities of national firms outside of the European Continent which are more or less enterprising.

.With respect to operations requiring the use of the dirigible, to the type of sites and to the environment.

.Etc ...

It provides, nevertheless, an acceptable evaluation of the aircrafts operating in Europe and outside of Europe by European companies.

Heavy Cargo	35 to 50 aircrafts
Medium Dirigible	35 to 150 aircrafts
Small Dirigible	95 to 250 aircrafts
Mini-Dirigible	135 to 300 aircrafts

NOTE : The high estimate of the heavy cargo market has been carefully reduced to 50 aircrafts from 72.

3.3. CASE OF DEVELOPMENT ZONES

/124

During the next few years, two very important cases shall be presented, which may be considered as examples, even if their analysis does not result in an estimate of the market potential.

Brasil

The development of the Amazon is a tremendous undertaking, by the distances which characterize the region (transamazonian highway, arterial highway of 5 200 km through the jungle, will open up the colonization of a region as vast as the United States), and having great wealth (the riches of the Amazon are enormous (80 % of the timber reserves of the Federation, 80 % of the fresh water, large reserves of iron, tin, magnesium, bauxite, copper, coal, etc., plus animal and fishery resources, etc ...).

This area should bring in "men without land" from the dry North East where thirty million Brasilians live in precarious conditions to the "land without men", as this area covers 59 % of Brasil, but represents only 8 % of the population.

The development program is considerable : more than 15 000 km of roads to be constructed in the middle of virgin forests ; development of one part of 50 000 km of inland water railways, including 20 000 which are already navigable ; construction of 125 airports in regions which may be reached only by surface transport, at the present time, etc ...

Furthermore, the government hopes to group more than ten million people around the transamazonian network, and accordingly to establish an urban network, which may be compared with the initiatives of the Russians in their Great Siberian North, but on a larger scale. The agro-cities will group fifty families and provide one elementary school, one medical center and a few stores. The "agropolis", centers of twenty agro-cities will group a thousand families of farmers, civil servants, businessmen and workers. It shall contain a secondary teaching center. Finally, every 150 km, cities or "ruropolis" will be created.

The establishment of this urban system will be an absolutely vast undertaking, and may be accomplished only if the equipment employed exceeds the capacity and effectiveness of equipment currently available. Even though an extensive study would be necessary, the establishment of a transport system by dirigible would in no way be incompatible with the creation of the transamazonian road system. On the contrary, acceleration of its construction would enable the rich industrial South to be united with the poor Northeast and Amazon, which have an immense potential, but which lack the means for its development.

The operation of an economical means of transport, which is not demanding in infrastructural requirements is possibly the only way to achieve construction and development results at a fast enough pace to prevent the social situation of the Northeast from deterioration. /125

According to this plan, (4) types of the dirigibles presented during this study would find a wide implementation.

The Antarctic

Research and explorations conducted up to the present time show the presence of deposits of coal, iron, oil and natural gas on this continent, as well as nickel, copper, uranium, gold, cobalt, etc ... The Antarctic also has an immense reserve of fish and crustaceans.

It also has a considerable fresh water source which Saudia Arabia has shown interest in.

This operation should be carried out on an international scale.

The development will involve large tonnage transports for which the following means shall enter into competition :

.Sea transport, which will require a discontinuity in the transport flow and a final transport by road route.

.Air transport requiring the installation of a heavy infrastructure resulting in high costs per ton/km.

.Transport by dirigibles, requiring minimum infrastructure and having minimum costs per ton/km.

Such an operation plan of the Antarctic should develop swiftly, commencing in the 1990's with a limited number of workers, due to circumstances.

A transport system by dirigible would call for four types of systems, described above, and would involve large fleets.

Ocean Development /126

The continental floor is almost exclusively used for its fish and petroleum resources.

Use of the dirigible for the detection of fishery zones, the fishing itself and the transport of the products has been considered by Russian experts, in particular.

The transports used for oil exploration and drilling become more and more complex and difficult to solve :

.Exploration and drilling zones are difficult to reach (off shore zones (North Sea - entire continental floor, Lake Maracaibo, etc ...).

.The drilling operations themselves are becoming more and more complex and require for this bulky equipment, which is heavy and expensive (deep-sea drilling, drilling in water zone, etc ...).

.The distance of the operated zones sometimes leads to the creation of a tube system, sub-marine, the construction of which involves large tonnages to be transported.

.Given the cost of the exploration and drilling equipment, it seems more and more necessary to reduce the periods of non use and to provide immediate re-use (a drilling device costs 80 000 F/day approximately).

In the case of the North Sea, for example, the following data must be taken into consideration :

.Average distances between land (Norway and Scotland) and sites of operation in the North Sea : 100 miles

.Type of operation sites to supply :

-drilling platforms
-pipeline laying and connection to the continent

.Type and intensity of respective traffics :

-platforms : per month and per site : 300 tons of piping and 150 tons of ciment and miscellaneous.
-laying of pipelines : per day and per site : 500-700 tons of pipes, deep-sea equipment, valves, etc ...

.Maximum unit weight : 100 tons

In addition the the re-supply of the sites, it should not be forgotten that the transport itself of the platforms, built and assembled on the coast requires towing operations to the sea of heavy and bulky masses, which could be carried out by the dirigible. /127

Sea armaments require considerable investments in sea transport equipment over the past few years. This activity could be partially assigned to the dirigible, if the latter appears to be adaptable to the transport and to the installation and construction operations.

Packages which could be assigned to the dirigible have quite variable weights and bulk, but are generally quite large (one derrick 40 m high, a winch weighs 30 to 40 tons) and with a lifting capacity of around 50 to 100 tons and would basically modify the techniques of exploration and extraction. The commercial load required for transporting the platform components for off shore drillings would naturally be much larger.

At the present time, most of the transport operations are by land ; the helicopter is used, in spite of its operating cost and high accident risk, but it cannot be used for loads exceeding a few tons.

The 50-100 ton dirigibles and 10-20 ton dirigibles (for the transport of crews, particularly, seem capable of meeting the needs of oil tankers ; this applies not only for sea zones, but any zone which is difficult to reach.

4. FINAL REMARKS /128

4.1. The Market Study Brings To Light Four Possible Applications :

The Mini-Dirigible With Commercial Load of 2.5 Tons (±)

Lumbering operations in temperate zones ; handling of small loads on rough ground and on operation sites ; various aerial work operations : surveillance, detection, photography, advertizing ... : transport of passengers connected with construction site operations

The Small Dirigible With Commercial Load of 10-20 Tons (±)

Lumbering operations in the euqatorial zone ; handling and unloading of ships ; various aerial work operations, particularly in the exclusive economic zone : surveillance, exploration, detection ; oil exploration and drilling works ; farming ; transport of passengers connected with construction works ; transport of tourists, etc.

The Medium Dirigible With Commericial Load of 50-100 Tons (±)

Handling combined with transports (containers, prefabrication, re-supply of construction sites) ; cargo transports over medium distances ; mass passenger transports ; cruises, etc ...

The Heavy Dirgible With Commercial Load of 250-500 Tons (±)

Transport and handling of heavy and indivisible loads ; transports of large industrial assemblies ; heavy transports (mining products, farm and forestry products, industrial products) over medium and long distances, etc ...

4.2. THE MARKETS

4.2.1. The mini-dirigible is capable of mass construction and large distribution ; the only lumbering operation in France would require about thirty aircrafts and operations for Europe would require from 60 to 100 aircrafts (according to studies conducted by Aérospatiale for the manufacture of the Helicostat). The entire market, including other applications, should mount to between 200 and 300 aircrafts in Europe, between 500 and 1000 on a world-wide scale.

4.2.2. The small dirigible would undoubtedly have a more limited and diversified market of about one hundred aircraft for Europe. It would have, however, a large distribution in zones of activity such as petroleum zones (off shore, zones of difficult access), the exclusive economic zone (surveillance, detection), developing regions (Amazon, Antarctic, etc ...), some farm and extensive crop regions, tropical forests for lumbering ; the implementation of large development projects (dams, city construction) constitutes a promising sector ; finally, passenger transports, either combined with large construction sites, or for tourists are areas of interest which should not be overlooked. The entire market limited to 100/200 for Europe should mount to 500 or more on a world-wide scale. /129

4.2.3. The medium dirigible shall have point to point applications and combined utilizations, for construction sites (laying of pipelines or high-voltage lines, for example), ports, factories for the prefabrication of buildings. Its market is probably the most difficult one to evaluate and there should be strong competition with surface transport means. Its capacity, however, permits the transport of heavy and bulky loads as well as of individually "light" and bulky loads, but which are grouped.

On the European scale, the market may be estimated at 30/150 aircrafts ; the range is very wide. On a world-wide scale, the market depends mainly on the rate of development and the rate of equipment in such zones as the Amazon, desert regions, polar regions, and, above all, the Antarctic; the exclusive economic zone and the oceanic zones are not assigned. Accordingly, the market may be very wide, but at medium term.

4.2.4. The heavy dirigible, due to its characteristics, exerts a sort of monopoly, which is either permanent (heavy and indivisible loads), or temporary (over routes where the amount of traffic does not warrant the establishment of heavy surface transport systems). Account taken of possible very diversified traffics (heavy loads, heavy farm or mining products, vehicles, containers, etc ...), the heavy dirigible should not be produced in mass manufacturings, but it would be appropriate to plan for the maximum number of components in common.

For the dispatch of heavy and indivisible packages, a market of 10 to 20 devices may be planned for Europe. The extension of these transports to the long-distance sector and for the evacuation/re-supply of heavy products (bulk products, farm or forestry products, spare parts) for the European market should place the demand at about 35 aircrafts.

On the world-wide scale, these estimates may be tripled, but the developing and equiping of new regions (North America, Amzon, Antarctic) may considerably modify these estimates, by an increase.

4.2.5. The Estimates Below Exclude Military Markets /130

4.3. Even if the dirigible makes use of known sub-assemblies and no new technology, the construction of the heavy dirigible must necessarily pass through intermediary stages, which are the mini-dirigible, the samll dirigible and the medium dirigible. Each type constitutes the probative model of the device with a larger commercial load.

Consequently, the reasonable schedule to propose must be (dirigible with seaworthiness certificate) :

Mini-Dirigible	1 - 2 years
Small Dirigible	3 - 4 years
Medium Dirigible	5 - 6 years
Heavy Dirigible	7 -10 years

4.4. The prototype manufacturing costs, serial and operating costs vary considerably from one project to another. The notion of kilometric cost, however, has only a relative value, since the operating conditions of the dirigible shall be only rarely comparable with other modes of transport.

4.5. If the heavy cargo dirigible seems more profitable from the point of view of operating costs (for concrete operations, the cost ratio between the transport by dirigible and by other modes should amount to 1 to 4), it is interesting to compare the requirement of passing through probative models of smaller commercial loads with the existence of substantial markets which correspond to such tonnages.

In these conditions, it is undoubtedly possible to plan - if financial means permit - the creation of a family of dirigibles, which may realistically be manufactured in ten years, with a heavy cargo dirigible, the demand for which would become imperative in the 1980's.

4.6. The evolution of needs, and the incapability of other modes to satisfy some of them, the attempt to save energy, to avoid congestions, to protect the environment, the need to transport into regions with difficult access, etc ... all contribute to the assumption that the dirigible may become an integral part of the general transport system and industrial system.